SOME ACCOUNT OF THE Institution, Plan, and Present State, OF THE *SOCIETY* FOR THE IMPROVEMENT OF *NAVAL ARCHITECTURE:*

WITH THE

PREMIUMS OFFERED BY THE SOCIETY,

LIST OF MEMBERS,

AND THE

RULES AND ORDERS OF THE SOCIETY.

TO WHICH ARE ANNEXED

SOME PAPERS

ON

SUBJECTS OF NAVAL ARCHITECTURE

RECEIVED BY THE COMMITTEE.

LONDON:

PRINTED (BY ORDER) SEPTEMBER MDCCXCII.

Now, in a country ſo fertile as Great Britain in men of genius, where the moſt ſkilful and induſtrious workmen are always to be found, and the beſt materials to be procured, nothing but public encouragement, and a firm union of theoretical with practical ability, can be wanting to produce the deſired remedy, and enable us to excel, not only our neighbours the French, but all other maritime countries, in conſtructing *Ships of War* and *Merchantmen.*

For theſe reaſons, and in order moſt effectually to accompliſh ſo deſirable a purpoſe, it was propoſed to eſtabliſh *A Society for the Improvement of Naval Architecture*; the grand object of which ſhould be, to improve and ſtrengthen the Royal Navy of Great Britain, and our ſhipping in general, for the benefit both of the Public and Merchants ſervice.

From ſmall beginnings great National Inſtitutions have frequently been eſtabliſhed on an extenſive ſcale. Such, for inſtance, is the preſent flouriſhing SOCIETY FOR THE ENCOURAGEMENT OF ARTS, &c. founded in 1753 by the indefatigable induſtry of Mr. William Shipley, who, deriving no advantages from learning, addreſs, or elocution, by unwearied perſonal attendance found means to engage a few perſons of rank and fortune to meet at *Peele's Coffee-houſe* in *Fleet-ſtreet*, and to adopt a plan ſimple in itſelf, but capable by improvement of producing the moſt beneficial effects to the Community.

munity. The meeting of a few intelligent, well-difpofed individuals produced the HUMANE, PHILANTHROPIC, and MEDICAL SOCIETIES. That great difcovery in Optics, the *Acromatic Glaffes*, was entirely owing to three or four ingenious men affembling at a public-houfe in *Spital-fields* to amufe themfelves in friendly converfation upon mathematical and mechanical fubjects.

THERE was every reafon to expect that fimilar fuccefs would attend the Affociation thus propofed to be fet on foot in order to improve and ftrengthen the *Wooden Walls* of *Old England*, the beft *Fortifications* of the *Britifh Iflands*. A MEETING, in confequence of a public Advertifement for that purpofe, was accordingly held at the *Crown and Anchor Tavern* in the *Strand*, on THURSDAY the 14th of APRIL 1791, to take into confideration the expediency of inftituting A SOCIETY FOR THE IMPROVEMENT OF NAVAL ARCHITECTURE. It was attended by a numerous company of Noblemen and Gentlemen, equally diftinguifhed for their rank, talents, and refpectable character; when, The Right Hon. LORD RAWDON having taken the Chair, it was unanimoufly agreed,

" THAT the Theory and Art of Ship-building
" being objects of the firft magnitude and importance
" to thefe kingdoms, and not fo well underftood in
" this country as matters of fo much confequence
" deferve, a Remedy for this radical deficiency

 " merited

SOME

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wards.—They have in view particularly to improve the theories of floating bodies and the resistance of fluids—to procure draughts and models of different vessels, together with calculations of their capacity, centre of gravity, tonnage, &c.—to make observations and experiments themselves, and to point out such observations and experiments as appear best calculated to further their designs, and most deserving those Premiums which the Society can bestow.

But though the Improvement of Naval Architecture in all its Branches be certainly the chief purpose of this Institution, yet the Society do not by any means intend to confine themselves merely to the form and structure of vessels. Every subordinate and collateral pursuit will claim a share of the attention of the Society in proportion to its merits; and whatever may have any tendency to render Navigation more safe, salutary, and even pleasant, not be neglected.

With such objects in view, the Society thought themselves justified in calling upon the Public for their countenance and support. Their call has been liberally attended to. And as they have every reason to expect support still more effectual, it is with confidence they repeat their solicitations for further assistance; such as may enable them to extend their views,—to make experiments on a

large

large ſcale,—to aſſiſt young perſons in the attainment of this moſt uſeful art,—and even to inſtitute an Academy for the regular ſtudy, not only of the art itſelf, but of thoſe ſciences which ought to form the baſis of it.

The List of Premiums will ſhew that the Members have not been inattentive to the objects of their eſtabliſhment; and in addition to theſe exertions, the Society has reſolved, by the aſſiſtance of their own Members and other Gentlemen properly qualified, to make a Series of Experiments, in the courſe of the Summer, on the reſiſtance of water, upon a much more extenſive ſcale than any which have yet been made in this or any other country.

But the Society do not merely call upon the Public for pecuniary aſſiſtance: In particular, they ſolicit the Officers of the Royal Navy and Merchants ſervices to examine carefully the hints, propoſals, and plans, which may at any time be laid before this Society; and to ſuggeſt any improvements that may occur, however minute they may appear to them; they being confeſſedly the beſt judges of the advantages to be derived from the facility of manœuvring ſhips, of the comparative excellence between one veſſel and another in ſailing, and all other deſirable properties.

They likewiſe ſolicit all profeſſional men, of what deſcription ſoever, employed in the conſtruction

and

and equipment of ſhipping, to aſſiſt the Society with their knowledge and experience, and to forward the views of this Inſtitution.

FINALLY, they invite men of eminence in the mathematical ſciences, as well in London as in our Univerſities and elſewhere, to co-operate with them in their views for the public good. And they will thankfully receive information from every deſcription of ingenious men, not only in this but in every other country.

The Terms of Admiſſion into the SOCIETY *are, a Subſcription of* TWO GUINEAS *Annually, or* TWENTY GUINEAS *for Life; to be paid at Meſſrs.* HANKEYS, HOARES, DRUMMONDS, *and* COUTTS, *Bankers; to any Gentleman of the Committee; or to* THOMAS CURRY, *Eſq.* Goſport.

The Books of the SOCIETY *are at No.* 1, Norfolk-Street, *where daily Attendance is given from Eleven till Three o'clock; and where all Information is deſired to be addreſſed to the Secretary.*

JOSEPH BROCKBANK, *Sec.*

PREMIUMS

OFFERED BY THE

SOCIETY.

I. NOTWITHSTANDING the Experiments which have been made in France and other countries, the laws of the refiftance of fluids do not appear to be fufficiently determined, particularly when applied to curved furfaces:

The Society, therefore, offer a Premium of One Hundred Pounds, or the Gold Medal, for the beft Series of Experiments with deductions tending to afcertain the laws of refiftance of water to folids of different forms, in all varieties of circumftances. A ftatement is required of the refpective dimenfions and velocities made ufe of in the Experiments.

II. The eftablifhed rule in England for cafting or computing the tonnage of fhips is as follows: Multiply the length of the keel, for tonnage, by the extreme breadth of the fhip, and alfo by the half of the extreme breadth, the product divided by 94 gives the tonnage of the fhip.

It

It is evident, upon the inſpection of this rule, that the tonnage ſo calculated does not alter in proportion as the principal dimenſions of ſhips vary; ſince not only the extreme breadth, and half of the extreme breadth, are both multipliers, but the height of the ſhip is not taken at all into conſideration; which circumſtances have undoubtedly a tendency (moſt of the charges on ſhipping being in proportion to their tonnage) to increaſe the length and height of ſhips beyond the proper limits; for an addition to the former adds proportionally but little to the tonnage, and the latter is not included in the calculation.

From theſe conſiderations, as well as from other inaccuracies alſo evident upon an examination of the rule—The Society offer a Premium of Twenty Guineas and the Silver Medal for the moſt ready and accurate method, by approximation or otherwiſe, for determining the tonnage of veſſels and ſhips of every deſcription, from an admeaſurement of all the principal dimenſions.

III. The Society offer a Premium of Fifty Guineas, or the Gold Medal, for the beſt plan, without any conſiderable diminution of the ſtrength of a ſhip's conſtruction, or her capacity for ſtowage, to make full-bodied ſhips, particularly when light, weatherly, that is, deviate or fall off the leaſt from the direction of their intended courſe.

IV. The

IV. THE SOCIETY offer a Premium of the GOLD MEDAL and FIFTY GUINEAS for the beſt and moſt practicable method of freeing ſhips from water, either by manual labour or any other natural agent.

V. THE SOCIETY offer a Premium of THIRTY GUINEAS, or the GOLD MEDAL, for the beſt method of aſcertaining the reſpective ſituation, due proportion, and number of the reſpective maſts and yards, ſuitable to veſſels of every claſs and deſcription.

VI. THE SOCIETY offer a Premium of the SILVER MEDAL and TWENTY GUINEAS for the moſt immediate and expeditious method of ſtopping the progreſs of fire on board of ſhips in every ſituation.

VII. THE SOCIETY offer a Premium of the SILVER MEDAL and TWENTY GUINEAS for the beſt and moſt ready method of ſaving a ſhip when by any accident ſhe may be in immediate danger of ſinking.

VIII. THE SOCIETY offer a Premium of the SILVER MEDAL and TWENTY GUINEAS for the beſt and moſt ready Method for ſecuring Magazines, Lazarettos, ſtore and ſpirit rooms, and other dangerous places, from taking fire on board of ſhips.

Candidates are required to deliver in their Papers to the SECRETARY *on or before the 1ſt of* OCTOBER 1792.

The

The SOCIETY *reserve to themselves the right of postponing the* ADJUDICATION *of any* PREMIUM *whatever, in case none of the* PRODUCTIONS *of* CANDIDATES *shall be found adequate to the* OBJECT *of such* PREMIUM.

And no person who shall propose to the SOCIETY *an* INVENTION *secured by* PATENT, *or already before the* PUBLIC, *will be admitted as a* CANDIDATE *for any* PREMIUM *offered by the* SOCIETY *relative to such* INVENTION.

By Order of the SOCIETY,

JOSEPH BROCKBANK, Sec.

N. B. *Other* OBJECTS *for* PREMIUMS *are under the Consideration of the* SOCIETY.

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Williams Alexander, Eſq. Chicheſter
Wilberforce William, Eſq. Old Palace-yard
Walden F. Capt. Carlſcrona
Whitmore Wm. Eſq. Upper Gower-ſtreet
Wentworth John, Eſq. Abingdon-ſtreet
Warre Henry, Eſq. Capt. R. N. Jermyn-ſtreet
Wagſtaff Joſeph Hague, Eſq. Highgate
Windham ——, Eſq. Portland-place

Young

Y.

Young William, Esq. Capt. R. N.
Young Sir George, Capt. R. N. Russel-street, Bloomsbury
Young Mr. Joshua, Rotherhithe

Gentlemen are requested to inform the SECRETARY *or Mr.* SEWELL *of any inaccuracies which they may observe in the above List. They are also desired not to consider it, however respectable, as the* LIST OF THE WHOLE SOCIETY, *many other Gentlemen having promised their support, though they have not yet paid their Subscriptions.*

RULES AND ORDERS

OF THE

SOCIETY.

ELECTION OF OFFICERS.

I. THERE shall be One President; Six Vice-Presidents at least; a Committee consisting of Twenty-four Members; a Secretary, Assistant-Secretary, and Collector or Messenger. The Vice-Presidents shall be nominated by the President, annually.

II. ALL the Officers of the Society (exclusive of the Committee) shall be elected Annually on the TUESDAY preceding the 14th of APRIL, or Anniversary of the Institution of the Society.

III. THE Six senior Members of the Committee for the time being, on any such Annual day of Election, shall go out of office, and Six new Members shall be added by Election to complete the number of Twenty-four.

IV. THE

Crookſhanks John, Eſq. Eton-ſtreet, Pimlico
Chatfield Allen, Eſq. Wanſtead, Eſſex
Cockerell Samuel Pepys, Eſq. Saville Row
Curtis George, Eſq. Colneyhatch

D.

Dent William, Eſq. Wandſworth Common
Delafonte Monſ. Surry-ſtreet, Black-friars
Debrett Mr. John, Piccadilly
Dalrymple Col. William, Blenheim-ſtreet
Ducie Lord, Berkeley-ſquare
De Gruchy John Phil. Eſq. Fenchurch-ſtreet
*Dundas Sir Thomas, Bart. M. P. Arlington-ſtreet
Darby John, Eſq. Old Jewry
Douglas James, Eſq. Kenſington
Daviſon Alexander, Eſq. Harpur-ſtreet
Daniel John, jun. Eſq. Mincing-lane
Dunſterville Thomas, Eſq. Plymouth

E.

Elliſton Edmund, Eſq. Lieut. R. N. Mortimer-ſtreet
Ellill John, Eſq. Cannon-ſtreet
Ebeling Mr. Daniel, Hamburgh
Elmſley Mr. Peter, Strand
Edwards G. Eſq. Capt. R. N. Richmond

F.

*Fiott John, Eſq. Fenchurch-ſtreet
Ferguſon Mr. James, Fenchurch-ſtreet
*Fraſer William, Eſq. F. R. S. Queen-ſquare, Bloomſbury

*Fiott

*Fiott Edward, Esq. Gosport
Farmer Richard, D. D. F. R. S. & A. S. Canon Residentiary of St. Paul's, Amen-corner
Frusbard Mr. James, Bengal
Fitzgerald John, Esq. Duke-street, Portland-place
Fairfull Robert, Esq. King's Bench Walks
Frankland Mr. John, Deptford
Francis John, Esq. Providence Rhode Island

G.

Garnett Mr. John, Eltham
Gore Charles, Esq.
Green Thomas, Esq. Gray's-inn
Glover Mr. Edward, Rotherhithe
Garlies Lord Viscount, Capt. R. N. Charles-street, St. James's
Greville Right Hon. C. F. F. R. S. King's Mews
Gaussen Samuel Robert, Esq. Mansfield-street
Grant Mr. William, King's Bench Walk
Grant Mr. Robert, Red-lion-square
Gamage D. William, Esq. Walthamstow
Grote Joseph, Esq. Badgmore, Oxfordshire
Gambier James, Esq. Capt. R. N. Wateringbury, Kent
Green John, Esq. Blackheath
Gribble Samuel Hicks, Esq. Adelphi
Gordon Edward, Esq. Bromley
Glenny George, Esq. Bromley Hill, Kent

H.

*Howe Earl, Admiral of the White, Grafton-street
Hallett John, Esq. Manchester-buildings
Hibbert Thomas, Esq. Upper Grosvenor-street
Hibbert George, Esq. Broad-street
*Hankey Thomas, Esq. Fenchurch-street
Harman Jeremiah, Esq. Finsbury
Hopkins Mr. Henry, Rotherhithe

Hamilton Thomas, Efq. Capt. R. N. Nurfted, Petersfield
Huddart J. Capt. Colebrook-row, Iflington
*Hutchinfon Mr. William, Harbour-Mafter Liverpool
Harris James, Efq. Crutched-friars
Hurlock, J. Efq. Linfey-row, Great Chelfea
Hays T. Efq. F. A. S.
Hutton Charles, L. L. D. Woolwich
Hall William, Efq. Royal Affurance
Horncaftle James, Efq. Kennington
Holford ———, Efq. Lincoln's-inn New-fquare
Haycraft Mr. Jofeph, Greenland Dock
Hughes Sir Edw. K. B. Vice Admiral of the Red, Portland place

J.

Jacob Mr. Henry, jun. Grove-ftreet, Deptford

K.

Knowles Sir Charles, Bart. Capt. R. N. Effex-ftreet
Key Mr. Jonathan, Paternofter-row
Kingfbergen Admiral, Carlfcrona
Kenfington Charles, Efq. Blackheath

L.

Leicefter Earl of, Pref. S. A. Grofvenor-fquare
Lawrence Richard, Efq. Camberwell
Locker W. Efq. Capt. R. N. Kenfington
Long Beefton, Efq. Bifhopfgate-ftreet
Lane Mr. Benjamin, Freeman's-court, Cornhill
Lee Sir William, Bart. Hartwell, near Aylefbury
Larkin Thomas, Efq. Blackheath
Larkin Mr. James, Blackwall

Lumley

Lumley Mr. William, Chancery-lane
*Long Samuel, Efq. Hill-ftreet, Berkeley-fquare
Legge, Hon. Capt. R. N.
Lee Mr. Rich. jun. Highbury-place
Lee William, Efq. Ditto
*Lane Richard, Efq. Edward-ftreet, Portman-fquare
Ley Thomas, Efq. Hampton-court

M.

*Mulgrave Lord, Capt. R. N. Hartley-ftreet
*Middleton Lord, Portman-fquare
Martin Sir Henry, Bart. Comptroller of the Navy, Navy Office
Martyn Rev. Thomas, B. D. F. R. S. Prof. Bot. Cambridge, Park Profpect
Mofer Mr. John, Frith-ftreet
Matthews Mr. William, Green Lettice-lane
Macaulay Alderman, Chatham Place
*Meftair Mr. Peter Everitt, Rotherhithe
Metcalfe Chriftopher, Efq. Weftham Mills
*Middleton Sir Charles, Bart. Rear Admiral of the Red, Hertford-ftreet
Mills Mr. A. Macclesfield, Chefhire
Mafkelyne Rev. Nevil, D. D. F. R. S. Aftonomer Royal, Greenwich
Martin Col. Claude, Lucknow, Bengal
Mayo Captain James, Bombay
Muller Captain, Stade
Mellifh Mr. Robert, Limehoufe
Manning William, Efq. St. Mary-axe
Manning William, jun. Efq. Billiter-fquare
Murray Mr. J. Fleet-ftreet
Mackintofh William, Efq. Temple
Mears ——, Efq. Piccadilly
Markham John, Efq. Capt. R. N. South Audley-ftreet
Morier Ifaac, Efq. Chefhunt
Morgan Francis Lewis, Mr. Weftm. Life Office
Mavor John, Efq. Fox Ordinary Court

Fourth Tuefdays in every month, at Twelve o'clock at noon, to prepare bufinefs for the Society at large, and their proceedings fhall be communicated to the next General Meeting.—The Prefident for the Time being fhall be a Member of the Committee; and not fewer than Five fhall be a Quorum. But in cafe Five Members fhould not be prefent before half paft Twelve o'clock, or in cafe the number prefent fhould be reduced by the departure of any of the Members, bufinefs may be proceeded upon by a lefs number, provided that the number of concurrent voices for the decifion of any queftion be not lefs than a majority of Five, that is to fay, Three, including the prefiding Member.

XVIII. The Committee may adjourn their meetings at pleafure.

XIX. The Secretary fhall fend notice of all Committee Meetings to the Members of Committees, at their ufual places of refidence, within the limits of the Penny-Poft.

XX. If the Committee fhall be defirous of the advice and affiftance of any Member of the Society, and fhall direct the Secretary to invite him to be prefent at their next Meeting, it fhall for that time be permitted that the Member fo invited may deliberate, confer, and vote upon all queftions, and act in every refpect as if he were in fact a Member of the Committee.

ORDER

ORDER OF PROCEEDINGS.

XXI. The Book of Rules and Orders, and the Subſcription-book, ſhall lie upon the table before the Preſident, Vice-Preſident, or Preſiding Member, at all Meetings; and at all Committees, before the Chairman.

XXII. Visitors ſhall be admitted at the ordinary General Meetings, but not at Special General Meetings or Committees.

XXIII. No perſon ſhall be admitted a Viſitor at any Meeting of the Society, unleſs he is introduced by a Member, who ſhall ſignify his deſire in writing to the Preſident, Vice-Preſident, or Preſiding Member. And no Member, except the Preſiding Member, ſhall introduce more than Two Viſitors at the ſame Meeting.

XXIV. The Preſident, Vice-Preſident, or Preſiding Member, ſhall read over the names of ſuch as deſire to be admitted Viſitors, as ſoon as he takes the Chair.

XXV. At all Meetings, except Annual Meetings for the Elections of Officers, buſineſs ſhall commence with reading the Minutes of the preceding Meeting.

XXVI. The Minutes and Reports of the Committees held ſince the preceding General Meeting ſhall next be read. Recommendations of Candidates for Election as Members ſhall be read: and then new matter may be offered to the conſideration of the Society by any of the Members.

XXVII. Such new matter as may ariſe out of the Minutes and Reports read before the Society ſhall be taken into conſideration previous to any other object.

XXVIII. Candidates for Election, either as Officers or as Members of the Society, may be balloted for during the tranſaction of ſuch other buſineſs as will admit of it.

XXIX. Every Member who has any new matter to propoſe, ſhall deliver it in writing to the preſiding Member, who ſhall lay it before the Society. No queſtion ſhall be put upon it, unleſs it be ſeconded: and no new matter ſhall be entered upon after Three o'clock: nor ſhall any Member be permitted to make a Motion after Three o'clock.

XXX. If the new matter delivered to the Preſiding Member according to the foregoing Article be of conſiderable length, or if the Preſiding Member ſhould perceive or know any other reaſon why the ſame ſhould not be immediately laid before the Society, he ſhall officially refer the Papers to the conſideration of the Committee for their Report at a future Meeting.

XXXI. No Premium or Bounty ſhall be offered until the Society ſhall have received the Report or Minute of the Committee relative to its object.

XXXII. All queſtions not otherwiſe provided for ſhall be determined by holding up of hands, unleſs Five Members, at leaſt, ſhall deſire a Ballot: and the Preſiding Member ſhall vote only in caſe of an Equality, or when the number preſent is leſs than a full Quorum.

XXXIII. At every Meeting of the Society and Committee, the buſineſs of ſuch Meeting ſhall be taken in writing by the Secretary, to be fairly copied into a book kept for that purpoſe, and regularly ſigned by the Preſiding Member.

ELECTION OF MEMBERS, &c.

XXXIV. Every perſon propoſed to be a Member of this Society ſhall be recommended by three Members, upon their perſonal knowledge of him or his works; the recommendation, in writing, containing the name, addition, and place of abode, of the perſon propoſed, ſigned by the Members propoſing him, ſhall be delivered to the Preſident, Vice-Preſident, or Preſiding Member, at a General Meeting, who ſhall cauſe the Secretary to read the ſame. It ſhall then be hung up in the Society's room, until after the next Meeting; and the Ballot ſhall

ſhall be made on the third Meeting after the recommendation has been read. If Two-thirds of the Members then preſent ſhall ballot in his favour, he ſhall be deemed a Member, as ſoon as he has ſigned the Obligation recited in the following Article, and has paid his firſt Subſcription, or compounded for Annual Contributions. If the Obligation be not ſigned, and the requiſite Payment made, before the expiration of Two Months after the Election, ſuch Election ſhall be void *.

XXXV. The Obligation to be ſigned by the Members ſhall be in theſe words:

"We whoſe Names are hereunto ſubſcribed "do hereby engage, each for himſelf, that We "will, to the utmoſt of Our power, promote the "Honour and Intereſt of the Society for the "Improvement of Naval Architecture, and "that We will obſerve the Rules and Orders of the ſaid "Society, ſo long as We continue Members thereof."

XXXVI. The Subſcription of each Member ſhall be Two Guineas, to be paid at the time of his Election, and Half-a-Guinea a Quarter, to be paid at the Four uſual Feaſts. Any Member ſhall be releaſed from the Obligation to Annual Contributions upon Payment of Twenty Guineas.

* It is ordered, that the privilege of becoming Members of this Society without Ballot, ſhall be extended to ſuch Gentlemen as ſubſcribe on or before the next Annual Election of Officers.

XXXVII. Mem-

XXXVII. Members who ſhall chooſe to reſign, and ſhall write a letter to that effect to the Secretary, ſhall of courſe be diſcharged from the Obligation, and ſhall ceaſe to be Members of the Society.

XXXVIII. Foreigners, or perſons not reſiding in Great Britain, may be elected Correſponding Members, without being ſubject to any Annual Payment. Such Members, during their occaſional reſidence in London, ſhall be admitted to the Society's Meetings upon the footing of Viſitors in their own right, without the uſual Introduction; but they ſhall not be entitled to any other privileges.

XXXIX. As ſoon as any perſon is elected a Member, the Secretary ſhall inform him of it by letter, and the Meſſenger ſhall wait on him, if in town, with a Book of the Rules and Orders.

XL. Any Member may have acceſs, at convenient hours, to the Books of Proceedings of General Meetings; but no copies or extracts ſhall be made, from any manuſcript books or documents in the poſſeſſion of the Society, unleſs by ſpecial and particular Order of the Committee, mentioning the copies or extracts permitted to be taken; which order ſhall be directed to the Secretary, and left with him to be filed.

XLI. If any Member ſhall wilfully and contemptuouſly diſobey the Orders of the Society, or ſhall attempt by writing or ſpeaking, or in any

other

other manner, to defame this Inſtitution, or if he ſhall do anything tending to the injury or diſgrace thereof, he ſhall be ejected out of the Society.

XLII. Whenever there ſhall be cauſe for the ejection of any Member, the Preſiding Member ſhall, at one of the General Meetings, propoſe that ſuch Member be ejected out of the Society. This propoſal ſhall be put to the Ballot, and if Two-thirds of the Members preſent ſhall vote for it, the ſaid Member ſhall be ejected, and his name ſhall be expunged from the Regiſter.

XLIII. No Member of the Society elected or admitted ſubſequent to the Fifth Day of *June* 1792, ſhall poſſeſs a Right to vote at the Election of Officers until his Name ſhall have remained Six Months upon the Books.

The preceding RULES *and* ORDERS *were ratified and confirmed at a* GENERAL MEETING *of the* SOCIETY, *held on the 12th Day of* JUNE 1792 *at the* Crown *and* Anchor Tavern *in the* Strand, SIR JOHN BORLASE WARREN, Bart. *V. P. in the Chair.*

Printed, by Order of the COMMITTEE.

JOSEPH BROCKBANK, *Sec.*

PAPERS
ON
SUBJECTS
OF
NAVAL ARCHITECTURE.

ARTICLE I.

TO MR. SEWELL.

SIR,

I HAVE juſt been informed by my friend Mr. HALLETT, that your very meritorious and ſpirited endeavours to eſtabliſh a Plan of Improvement of Naval Architecture had met with ſucceſs; and that a SOCIETY had been formed for that very deſirable and much-wanted purpoſe. For I believe I may very truly ſay, extraordinary as it may appear, that no ſcience lies under more abſurd and ridiculous prejudices as to its firſt principles, or in which greater and more obvious improvements may be made, if

those prejudices were once removed, and a simple and plain plan of improvement was adopted, by means of experiments well executed, in order to establish, beyond a doubt, the first principle of a science so necessary to a Maritime Nation, where every discovery which can contribute to swift and safe Navigation may be truly said to be invaluable.

It is to you, Sir, as the first mover of this very laudable undertaking, that I think I ought to address myself, and to offer some observations which I have, in the course of a good deal of practice and the particular pleasure I have always had in Navigation, had occasion to make; and I send you, inclosed, some Experiments which I made some time ago. The result of these (being so different from what has been, in general, adopted as the first principles in Naval Architecture) I should offer with a degree of diffidence, had I not repeated them so often as to incline me to believe they are not unexact, and that, whenever the same Experiments are made, the same result will appear.

I do not, however, offer them to the Society as conclusive, but only in hopes that, in a point upon which depend the First and Essential Principles

ciples of Naval Conſtruction, it will be thought that it is abſolutely neceſſary that authentic and ſure Experiments ſhould be executed with the utmoſt care and preciſion, in order to eſtabliſh and aſcertain, beyond a doubt, thoſe principles, and effectually to contradict and put an end to thoſe notions, which have hitherto prevailed, ſhould it appear, on experiment, that they are without foundation, as I believe is really the caſe; I mean in regard to the FORM OF FISHES for dividing the fluid, and the towing of timber. What I wiſh, then, to propoſe is, that Experiments ſhould be made for that purpoſe, and I incloſe you a copy of thoſe I have made. If thoſe which the SOCIETY may think proper to make ſhould agree with mine, it will be a farther confirmation. They ſhould certainly be tried in every manner that can procure a deciſive and final concluſion; and they cannot be executed with too much care and exactneſs. Should the SOCIETY think proper to adopt the firſt principle, I will then take the liberty of offering them ſome Experiments upon the form of Midſhip-frames, proper to carry the moſt ſail with the leaſt reſiſtance, and which are perfectly reconcileable with the lines which meet with the leaſt reſiſtance in the progreſſive motion. It is the *uniting theſe two qualities* which conſtitutes a faſt-

 ſailing

failing Veffel, and which muft be fuch as are capable of being adapted to Veffels of all forts and fizes, from a Cutter to a Firft-rate Man of War. I flatter myfelf that it is not difficult to demonftrate this effential point, which I fhall be ready to do with the utmoft pleafure, if I learn, by your anfwer, that my doing fo can be ufeful or agreeable.

I am, SIR,
Your moft obedient
Humble Servant,
CHARLES GORE.

Pyrmont.

OBSERVATIONS ON THE RESISTANCE OF FLUIDS, AND ON THE METHODS TO BE MADE USE OF TO ASCERTAIN THOSE FORMS OR LINES WHICH MEET WITH THE LEAST RESISTANCE; AND WHICH MUST BE SUCH AS ARE CAPABLE OF BEING UNITED WITH THAT FORM WHICH GIVES THE GREATEST POWER OF CARRYING SAIL.

THAT form which gives the greateft power of carrying fail, muft be fubject to a feparate inquiry, and muft be fuch as can be adapted to thofe lines which are found to have the leaft refiftance poffible in progreffive motion. One, without

without the other joined with it, is uselefs; but being united, and forming lines proper to be used in the construction of Vessels of all ranks and sizes, they constitute the First Principles of Naval Construction; in short, the real solid of least resistance, which at the same time possesses the greatest power of carrying sail.

The first of these is the subject at present in question.

The Experiments I have seen on this matter are, viz.

1st, Those published by Murray, in his "Treatise on Ship-Building."

2d, Monsieur le Camus "sur Forces Mouvantes."

3d, Mr. Chapman's Experiments, which are found in his Treatise translated into the French from the Swedish.

The first were made by Mr. Bird, an eminent Ship-builder in the River, about forty years ago. The result of these trials is, that solids, which have their extreme breadth at $\frac{1}{3}$ from the extremity, meet with the least resistance, I think about $\frac{1}{9}$.

ſailing Veſſel, and which muſt be ſuch as are capable of being adapted to Veſſels of all ſorts and ſizes, from a Cutter to a Firſt-rate Man of War. I flatter myſelf that it is not difficult to demonſtrate this eſſential point, which I ſhall be ready to do with the utmoſt pleaſure, if I learn, by your anſwer, that my doing ſo can be uſeful or agreeable.

I am, SIR,
Your moſt obedient
Humble Servant,
CHARLES GORE.

Pyrmont.

OBSERVATIONS ON THE RESISTANCE OF FLUIDS, AND ON THE METHODS TO BE MADE USE OF TO ASCERTAIN THOSE FORMS OR LINES WHICH MEET WITH THE LEAST RESISTANCE; AND WHICH MUST BE SUCH AS ARE CAPABLE OF BEING UNITED WITH THAT FORM WHICH GIVES THE GREATEST POWER OF CARRYING SAIL.

THAT form which gives the greateſt power of carrying ſail, muſt be ſubject to a ſeparate inquiry, and muſt be ſuch as can be adapted to thoſe lines which are found to have the leaſt reſiſtance poſſible in progreſſive motion. One, without

without the other joined with it, is uſeleſs; but being united, and forming lines proper to be uſed in the conſtruction of Veſſels of all ranks and ſizes, they conſtitute the Firſt Principles of Naval Conſtruction; in ſhort, the real ſolid of leaſt reſiſtance, which at the ſame time poſſeſſes the greateſt power of carrying ſail.

THE firſt of theſe is the ſubject at preſent in queſtion.

THE Experiments I have ſeen on this matter are, viz.

1ſt, THOSE publiſhed by MURRAY, in his "Treatiſe on Ship-Building."

2d, MONSIEUR LE CAMUS "ſur Forces Mouvantes."

3d, MR. CHAPMAN's Experiments, which are found in his Treatiſe tranſlated into the French from the Swediſh.

THE firſt were made by Mr. BIRD, an eminent Ship-builder in the River, about forty years ago. The reſult of theſe trials is, that ſolids, which have their extreme breadth at $\frac{1}{3}$ from the extremity, meet with the leaſt reſiſtance, I think about $\frac{1}{9}$.

 Theſe

Thefe Experiments were tried with only one degree of velocity, and in that refpect are imperfect.

Monsieur le Camus feems to agree with Mr. Bird.

The third, by Mr. Chapman, contradicts thefe Trials, which do not agree with the Experiments tried by him; and he imagines this was owing to Mr. Bird's being tried in fhallow water and a narrow ciftern.

I think (not having his book with me) that he finds the folid which had the extreme breadth in the middle and each end equally fharp, met with the leaft refiftance with a fmall weight; but, being drawn by a greater weight, had fomething more velocity when the breadth was carried forward, but not in proportion to Mr. Bird's, Monfieur D'Alembert's, made at Paris by order of Monfieur Turgot, feems to decide in favour of a fharp entrance, to a greater degree than can be well ufed in naval conftruction; and his book, in which the refult of thefe trials is publifhed, entirely explodes all idea of afcertaining this matter by calculating it in any other manner than by Experiment; but the form of the

Models

Models made ufe of on this occafion being compofed of angular fhapes, with fharp points and corners, it is difficult to fay whether thefe Experiments are entirely applicable to real conftruction. There are alfo, I believe, fome Experiments, or Calculations, made by the Chevalier DE BORDA on this fubject, which are publifhed in the "Tranfactions of the Academy of "Sciences," but which I have not feen.

THE Experiments, of which I fend you inclofed a copy, do not agree with any of the above entirely. The two folids whofe extreme breadth is at $\frac{1}{3}$ from their end (being the forms given by Mr. BIRD and Monfieur LE CAMUS) were, on a great many trials, always confiderably beat by the others whofe extreme breadth was in the middle; and this was repeated with the fame refult found fo many times, that I am much inclined to believe the fame will be the cafe whenever the Experiment is fairly executed; which fhould be done on a piece of water fufficiently wide and deep as to take away the objection ftarted by Mr. CHAPMAN. Thefe two folids had lefs immerfion, or body, than the others, in proportion to oz. $15\frac{1}{8}$ to $19\frac{1}{4}$ and $20\frac{1}{8}$, though they had the fame fail, and, confequently, ought to have had more velocity, having lefs body to impel

through the fluid: if, then, the others had confiderably the advantage, it muft have been owing to the better form. But that of oz. 19¼, being narrower, went confiderably the beft; and, contrary to Mr. CHAPMAN's Experiment, the ftronger the wind, the more evident advantage the folids had whofe extreme breadth was in the middle.

IN regard to the Experiment I have made upon the fpar of timber (a copy of which I fend you *), I found, upon repeated trials (performed in the prefence of an eminent Ship-builder, who confidered the Experiment as fairly tried), that the fmall end always met with a great deal lefs refiftance, being prevented from fhearing, though otherwife floating at liberty; which has induced me to believe that the idea, generally received as a maxim, and, I believe, conftantly practifed, has been occafioned by the manner in which it is done, with a certain length of rope to the ftern of a boat, which permits the fpar to fheer, which it is more fubject to do with the fmall than with the large end foremoft.

I SUBMIT thefe Experiments, and the manner in which they were tried, to the SOCIETY; and I fhould offer them with great diffidence, as they

* See page 11.

feem

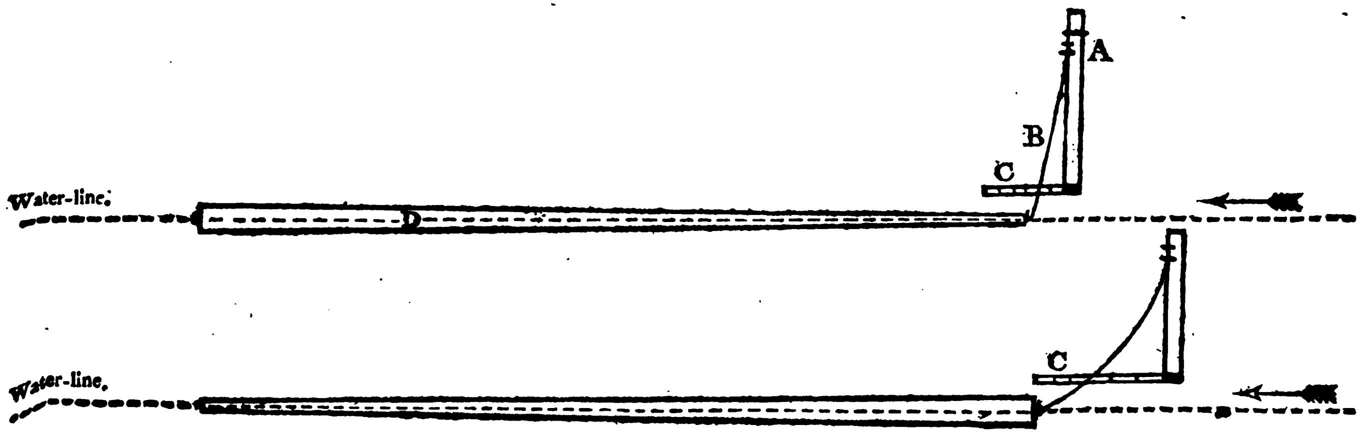
ſeem to contradict notions hitherto generally received (though I believe ſeldom examined), had I not repeated them ſo often, with the ſame reſult, as to induce me to think they are not unexact. I do not, however, offer them as concluſive, but as a farther reaſon, added to the difference which has been found between the Experiments on this eſſential point, made by experienced and able Builders, to ſhew how neceſſary it is that a ſet of experiments ſhould be made with the utmoſt care and judgment, in order finally to decide and aſcertain a point upon which *the Firſt Principles of Naval Conſtruction* depend, and in order to remove and explode certain prejudices (if ſuch they ſhould be found to be), and to which thoſe who project the plan of Veſſels may have recourſe, as a ſure rule and principle of their art.

These Experiments ſhould then be tried with the utmoſt care, and in different manners, and I ſhould think with Models of about three feet long and from ſix to eight inches thick, of ſolid wood, made with the utmoſt accuracy; the form of Fiſhes being by many conſidered as a rule to follow; and which ſeems ſcarce to merit mentioning, were it not neceſſary to remove prejudices in order more effectually to eſtabliſh the real fact. For what analogy can there be between the Form of Fiſhes, and the manner in

which they move by the action of their tail, and the compact body of a vessel, which is impelled by her sails? The length of tail in a Fish is necessary to its velocity, which naturally carries the extreme breadth near the extremity, with a certain strength in the shoulders to put that tail in motion.

If, therefore, upon trial, it shall be found that Mr. Bird's solids have the least resistance, and which, like a Fish, have their extreme breadth near the end, the shape of a Fish, which necessarily has also its extreme breadth at the shoulders, would not be the more a rule for Naval Construction, being entirely of a different nature and moved in a different manner. But why have recourse to reasoning of this kind, when a plain and simple Experiment, properly tried, will ascertain the fact, and the real solid of least resistance, such as can be applied to Naval Construction, clearly established, and which may serve, in future, as an indisputable rule to go by? The contradiction which seems to exist in those Experiments which have been already tried, wherein the Models, which had their extreme breadth placed only one-third from forward, were always beat, notwithstanding they had the advantage of equal sail and less body, will certainly supply the trouble and expence of a Set of Experiments.

EXPERIMENTS *made upon the* RESISTANCE *of the* FLUID *to the* DIFFERENT ENDS *of a* PIECE *of* TIMBER, *tried alternately.*



A. is a piece of wood with an elaſtic lath, or ſpring, *B.* fixed to it; which, being at liberty to bend according to the force applied, yields more or leſs; and *C.* is a horizontal piece, added, to mark exactly the proportion and effect of that force; *D.* is a maſt, or ſpar, of wood, large at one end, and terminating nearly in a point at the other.

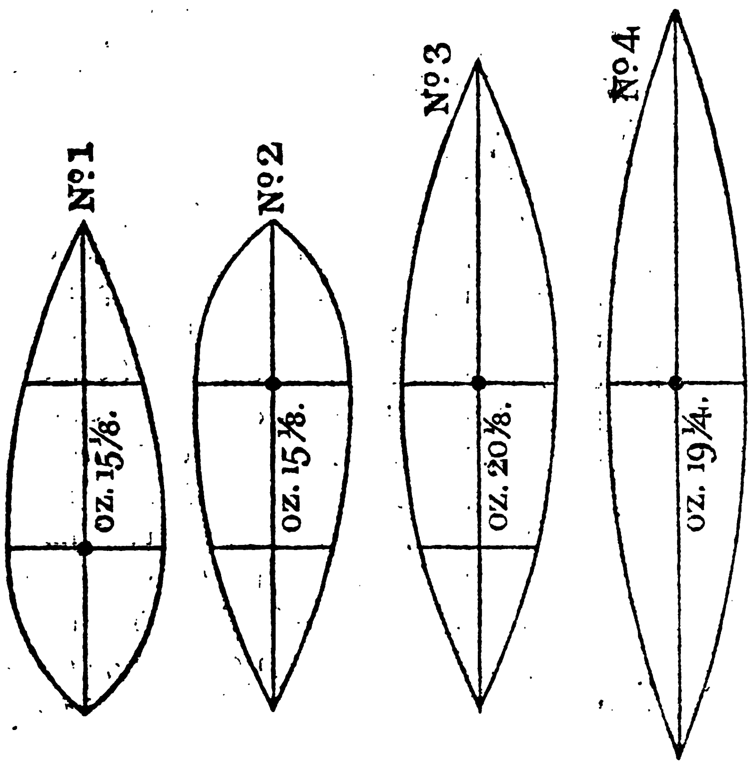
The machine *A.* being placed over the ſide of a veſſel, in the tide's way, and at ſuch a diſtance (about five feet) as not to be affected by the veſſel; the ſpar *D.* having a ſtaple drove into the centre of each end; one of theſe ends is brought to the lath *B.* which has a ſmall hook fixed in order to fix the ſpar by the ſtaple, and in ſuch a poſition as to leave the ſpar to float horizontally on the water, without raiſing or depreſſing the end brought to it; at the ſame time preventing it from ſheering about to the right or left (the lath being then but about half an inch broad).

The tide, or current, being left to operate upon the ſpar, that lath was more or leſs drawn, and the diſtance marked upon *C.* The end of the ſpar was then changed, and the diſtance marked as before.—This Experiment was re-

peated,

peated, by changing the ends a number of times. The reſult was, That it appeared clearly (the ſpar not being permitted to ſheer), that the reſiſtance from the full end was very conſiderably *greater* than that of the ſmall end of the ſpar.

EXPERIMENTS *tried in order to aſcertain the* RESISTANCE *of* FLUIDS *upon the* SOLIDS *of* DIFFERENT FORMS *and* PROPORTIONS.



No. 1 and 2 were exactly of the same form, having their extreme breadth at $\frac{1}{3}$ from the end, and weighed oz. 15$\frac{1}{8}$.

No. 3 had the extreme breadth in the middle, each half being exactly like the sharp end of No. 1 and 2, and weighed oz. 20$\frac{1}{8}$.

No. 4 weighed oz. 19$\frac{1}{4}$, and was longer and narrower than the others, having both ends exactly equal, and the extreme breadth in the middle.

N. B. All these Models were about two inches thick, and No. 4. was about two feet long, the rest in proportion.

No. 1 and 2, being exactly of the same shape and weight, were tried; No. 1 with the sharp end foremost, No. 2 with the full end. Upon a number of repeated trials, the difference seemed small, though rather in favour of the sharp ends foremost when it blew fresh; otherwise it seemed, that what the sharp end gained by less resistance, it lost by the suction occasioned by the full stern. —*N. B.* All the Models had the same sail, of equal size and weight, being a square thin board placed upright *(See the Description of the Manner in which this Experiment was tried).*

These

Theſe two Models, therefore, having the ſame ſail, and having leſs immerſion (weighing only oz. $15\frac{1}{8}$), had their forms been equally good, ought to have had more velocity than No. 3 and 4 (which weighed oz. $20\frac{1}{8}$ and $19\frac{1}{4}$): they were, however, beat very conſiderably at every trial without exception.

No. 3, weighing oz. $20\frac{1}{8}$, but with the ſame ſail as No. 1 and 2, beat No. 1 and 2 conſiderably, having its extreme breadth in the middle. No. 4, weighing oz. $19\frac{1}{4}$, but being longer and narrower, the extreme breadth in the middle, beat all the others conſiderably. This experiment ſeems to ſhew the advantage of a ſharp entrance, and a ſtern equally ſo; the firſt to open, the ſecond to deliver, the fluid without ſuction (which, in theſe trials, ſeemed to impede in No. 1, as much as the full end in No. 2, by the reſiſtance it met with). They ſhew alſo the great advantage of length in proportion to width; and if it appears that No. 3 and 4 had ſo great advantage, having only the ſame ſail, though they had more area of body and immerſion to drive through the water, it would be concluſive to adopt that idea (theſe Experiments being fully confirmed by others made with the utmoſt care and accuracy) in naval conſtruction.

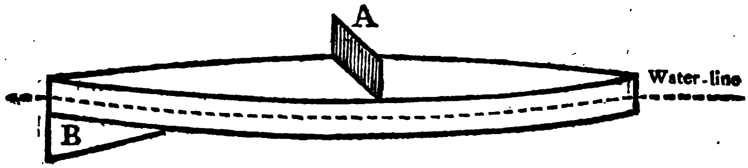
THERE

There can be no doubt but that No. 2, being of the fame width with No. 1 and 3, but having more area in proportion as 20 $\frac{1}{8}$ is to 15 $\frac{1}{8}$, would carry more fail.—Then, if it beat No. 1 and 2 with the fame fail, what would it do with the fail it could carry?

No. 4 being oz. 19¼, but not fo wide, though larger, would carry fomething lefs fail, in proportion, than No. 3; but it went much fafter, in proportion.

The Experiment would have been ftill better tried had the Models been thicker, perhaps 4 inches, which would have rendered the difference of the lines more fenfible.

The manner in which thefe Experiments were made was as follows:



A. is a flat piece of thin board, placed upright to ferve as a fail; and *B* is a fin, or fort of rudder, of thin board alfo, each being of equal weight and fize. The rudder, *B*, ferves to govern the model, in a ftrait line, down the wind.

Each

Each ſolid, being arranged as above, was placed in a line with the others, at about a foot diſtance, and impelled by the wind with more or leſs velocity as their form was more or leſs proper to divide the fluid.

The piece of water on which this Experiment was made, was in a large field, at a diſtance from trees, and nearly full to the edge, there being no impediment to prevent the wind from acting equally on each model; and the ſame trials were repeated ſeveral days, and a great number of times, No. 1 and 2 being always beat, though the Experiments were executed by able and experienced perſons, will, however, ſhew with how much care and preciſion it is neceſſary ſuch Experiments ſhould be tried, in order to leave no doubt as to their reſults being to be depended upon.

The methods uſed by Mr. Chapman and Monſieur D'Alembert (which are very exactly deſcribed in their books) ſeem unexceptionable. They ſhould be executed upon a large and deep water, and with different velocities, and by perſons of great accuracy, who are accuſtomed to Experiments; and the ſolids made uſe of ſhould be executed with the greateſt exactneſs in ſolid

wood, of about three feet long, and eight or ten inches deep.

If the Society think proper to order these Experiments, which will determine the solid of least resistance in progressive motion, I will take the liberty of proposing a set of Experiments upon the form of Midship-frames, which will be proper for the Construction of Vessels of all sizes, and which, without diminishing the velocity or altering those lines which shall be found to have the least resistance, shall possess the power of carrying sail in the greatest degree.

These two qualities, joined together, form, in my opinion, the First Essential Principles in Naval Construction.

ARTICLE II.

To the Committee of the SOCIETY *for the Improvement of* NAVAL ARCHITECTURE.

GENTLEMEN,

I AM happy to have feen fo favourable a beginning to a SOCIETY, which I have no doubt will in the end prove highly beneficial to the Naval purpofes of this Country. It will, I conclude, take fome time to eftablifh proper arrangements for carrying on the bufinefs of the SOCIETY; and, till thofe are finifhed, I fhould be forry to divert your attention to other objects.

THE inclofed Memorandums are therefore only meant as HINTS, to be laid on the table, till the COMMITTEE have leifure and opportunity to look at them.

THEY were fuggefted to me by the many applications that came before the NAVY-BOARD when I prefided at it, and from the variety of contradictory opinions that were offered on the occafion.

I HAVE alſo ſent, for your information, a very valuable paper which I have received from Captain CHARLES PATTON of the Navy; and as it relates entirely to one of the firſt objects propoſed by the SOCIETY, I earneſtly recommend it to their peruſal.

I HAVE only to add, that I am ſorry not to have it in my power to attend your Meetings as often as I could wiſh, and that I ſhall on every occaſion be happy to communicate what may appear to me deſerving your attention, and give every other aſſiſtance in my power towards the ſucceſs of ſo important an undertaking; being, with great reſpect and eſteem,

GENTLEMEN,

Your moſt obedient,

and moſt humble Servant,

CHARLES MIDDLETON.

HINTS

H I N T S

FOR THE

COMMITTEE

OF THE

SOCIETY FOR THE IMPROVEMENT OF NAVAL ARCHITECTURE.

TO ascertain the beſt manner of conſtructing Maſts for Ships of the Line, ſo as to give the greateſt degree of ſtrength with all poſſible lightneſs: the ſame as to lower Yards.

MEMORANDUM, *All large Maſts, previous to the laſt war, were made of* New-England *White Pine, having been found the lighteſt, and in all reſpects beſt ſuited to the purpoſe. The ports of the Colonies being at that time inimical, and the demand increaſing, the* NAVY-BOARD *were under the neceſſity of procuring a ſupply from* RIGA: *and as the largeſt ſticks from that country ſeldom exceeded twenty-four inches diameter, but more frequently from nineteen to twenty-one, a much larger number of pieces were of courſe uſed in conſtructing Made Maſts.*

FROM this circumſtance, and the nature of the wood, being conſiderably heavier than White

Pine, the Maſts now in uſe exceed the former ones by nearly one quarter in weight; and though Riga Maſts are, if uſed ſingle, conſiderably ſtronger than thoſe of New England, yet I am apprehenſive, from the additional weight when worked into Made Maſts, they will not, under all circumſtances, ſtand ſo long as the White Pine of America. It is alſo evident, that a ſhip cannot keep up her ſides ſo well under this increaſed weight as ſhe did under the leſs one, and that ſhe muſt ſtrain conſiderably more in a ſea.

The ſize of the Riga Maſts were reduced as far as was thought prudent; but the difference of weight is ſtill conſiderable, and nearly what I have ſaid. The ſize of the Rigging, bearing a proportion to the height and weight of the Maſt. muſt neceſſarily be conſidered.

The ſubject appears to me an important one, and it is therefore ſubmitted for conſideration.

The White Pine of America I conceive to be what is called here the Weymouth Pine. It is conſiderably cheaper than Riga of equal dimenſions, and on that account deſerves attention.

Ex-

Experiments are wanting on the proper Height of Mafts and Squarenefs of Yards: fome contend for one, and fome for another; but no comparative trial has been made within my knowledge, though many have applied in favour of one and the other.

It is ftill a doubt whether Cable or Hawfer-laid Cordage is the beft for ftanding Rigging, and what is the moft efficacious mode of preferving it from the weather without injuring the materials.

The beft manner of Conftructing or Difpofing of the Hold as to Stowage and Safety.

To what extent Copper and Iron may be ufed in Knees, &c. fo as to preferve ftrength and lightnefs, and fave Knee-timber, which is become fcarce, and not to be had.

The practicability of Moulding Timber where the Trees grow, fo as to fave time and carriage, and accelerate the fecuring and conftruction of Ships.

WHETHER the Foreſts, in this way, might not become magazines for timber, and prevent ſuch quantities being kept in a ruined ſtate in the Dock-yards, to the great injury and waſte of timber, and unneceſſary occupation of ſpace, &c.

ON the ſhorteſt time in which a ſhip may be put together in this way.

THE propriety of Building Ships under Covered Roofs, as in Venice, and of keeping them in their Slips in the King's and Merchants Yards when built, and how far it may be proper to forward them in this way, ſo as to admit of their being ſoon completed, when wanted, without injury to the ſeaſoning; or, in other words, the ſtate of forwardneſs they ſhould be left in to attain theſe ends.

EXPERIMENTS on the Duration of Winter-felled Timber, compared with Timber barked ſtanding, and which has ſtood two years or more afterwards, and Timber barked after being cut down. It is ſubmitted, Whether uſing it in different parts of the ſame Ship, under water, may not be the beſt means of proving it?—This trial was agreed on before I left the NAVY-BOARD;

BOARD; but the multiplicity of buſineſs tranſacting there will make the Experiment more ſatisfactory in the Hands of the SOCIETY.

ON the beſt Conſtruction of Capſtans for purchaſe and ſafety.

THE beſt Kind of Boats, for general uſe, in King's Ships of all Claſſes.

THE beſt Kind of Pumps for general uſe, the Number for each Claſs of Ships, and the beſt Places for fixing them.

MEMORANDUM. *The preſent Chain-Pump is not to be relied on in time of danger.*

THE quantity of Iron Ballaſt beſt adapted to Ships of different conſtructions. The beſt Manner of Stowing it, ſo as to procure ſtiffneſs and eaſe in the ſea, and room in the Hold, and to maintain at the ſame time the beſt ſailing qualities.

THE ſame as to Shingle Ballaſt.

To what Extent that very ingenious and uſeful plan of Captain SCHANK, on the Advantages of Sliding Keels, may be carried.

THE

The beſt Conſtruction for Packets, Store-ſhips; Rollers for Hawſe-holes; Blocks of every kind; Buoys; and the moſt likely means for Encouraging the Propagation of uſeful Timber.

I am aware that ſome of theſe propoſitions do not literally come within the views of the Society; but as they have a very near connection with the ſubject, and are more likely to be accurately examined by them than any other body I am acquainted with, I have ventured to lay them before the Committee.

Charles Middleton.

To Sir C. Middleton, Bart.

Sir,

I have carefully peruſed the propoſal for eſtabliſhing a Society for the Improvement of Naval Architecture, which you were ſo obliging as to put into my hand; ſince that time, I have ſeen an Address from the Society to the Public; in which they declare, that "They "have in view particularly to improve the "theories

"theories of floating bodies, and the resistance "of fluids: to make observations and experi"ments themselves; and to point out such "observations and experiments as appear best "calculated to further their designs."

In this Country, the study of the theories of floating bodies, and resistance of fluids, has been totally neglected. In France, the very contrary has been the case; men of real genius and observation have employed their talents in improving this science, and have brought it to a considerable degree of perfection. What was known in France near a century ago, to every person who pleased to make it any part of their study, is not, at this moment, known in England to many of those, who, as professional men, fill the first departments in their line under Government.

In order to forward the views of the Society, and remove this National Reflection, I know of no method likely to prove so speedy and effectual, as by getting some of the best French authors, who have written on those subjects, translated into English.

faſter through the water than the ſame ſmall power applied below, for this reaſon. The force applied at the head of the maſt, which may be called the end of the lever, will act upon the ſhip in two different ways; to give her progreſſive motion, and to turn her upon her axis in a longitudinal direction. The tendency to turn on her axis will be oppoſed by the reſiſtance of the fluid in which ſhe floats; but that fluid, when the preſſure upon it from the ſhip's inclination to turn on her axis is but ſmall, eaſily yields, and by this means increaſes the progreſſive motion in a greater degree than an equal force would do if applied farther down upon the maſt, or on a level with the water. But when the force or impulſion at the head of the maſt is increaſed to a certain degree, this effect will ceaſe; becauſe the preſſure on the fluid, from the ſhip's inclination to turn on her axis, is increaſed in proportion to the force applied at the maſt-head, while the ſhip's progreſſive motion is reſiſted in proportion to the ſquares of her velocity.

If this be a juſt ſolution of the problem, it will follow, that ſhort and broad veſſels, which have the greateſt tendency to turn on their axes in a longitudinal direction, will ſooner loſe the benefit to be derived from high ſails by an increaſe

uniformly affirm, that they find the contrary to be the cafe from experience. Strongly attached, however, to his own theory, he endeavours to prove what experience rejects.

It is not improbable that this error of Mr. Bouguer has been the caufe of many of the French fhips of war, and perhaps the Englifh too, being too fquare rigged.

It is a common obfervation, and, I believe, in general a true one, that a top-gallant fail, fet alone in its proper place, will give a fhip a greater degree of velocity, in a light breeze, than a main fail, fet alone in its proper place, in the fame breeze, would do. Seamen account for this by faying, that there is more wind aloft than below, and that fails made of thin canvas draw better, in a light breeze, than fails made of thick canvas. But neither of thefe reafons, nor both taken together, are fufficient to account for this effect. The fame thing, I believe, will hold good if the experiment were made on a boat, or even on a model of three feet long.

I suspect it will be found (and it may eafily be tried by experiment), that a fmall impelling power, at the head of a maft, will force a fhip fafter

a good wind; and it is for this reaſon that four maſts can never be put in a ſhip of a great length with the ſame advantages which three muſt produce.

Mr. Miller, of *Dalſwinton* in *Scotland*, who has made many Experiments on veſſels at a great expence, has not been able to do juſtice to his own Experiments, for want of a knowledge of the principles on which they ought to have been maſted. He built a long, flat, and narrow veſſel, and rigged her with four low maſts; ſhe did not anſwer, and it was impoſſible that ſhe ſhould: but had ſhe been properly maſted, ſhe would, in all probability, have anſwered his expectation. He built a veſſel upon two long, narrow, and quite flat bottoms: this conſtruction required rather tall maſts and narrow yards, but he rigged her with five low maſts; the conſequence was, that ſhe fell to leeward in the moſt moderate breeze with ſmooth water; ſhe could only ſail large, yet the conſtruction of the veſſel was not improper for keeping a wind.

The generality of the ſhips in the Coal-Trade are rather long, and particularly ſo in the floor; this conſtruction, according to the foregoing theory, ſhould anſwer beſt with tall maſts and

narrow

narrow yards; and Experience has taught them to rig their veſſels in this manner. Some people imagine that they adopt this method for convenience in narrow channels; but I have been aſſured by many of them, that they find their veſſels ſail better, and keep a better wind, when rigged in this manner.

THERE are a kind of Dutch veſſels, very long, flat, and narrow, which may conſtantly be ſeen in the river Thames, and which ſail and work very well. Experience has taught the Dutch to rig thoſe veſſels high and narrow; the foot of their ſails do not extend over more than two thirds of their length; they are galliot-rigged, with a ſmall mizen cloſe aft.

I HAVE obſerved, in Holland, that they do not fix the rope by which they track their veſſels, on a line with the men or horſes which drag them, but conſiderably higher up on the maſt. But if they were to drag a globe through the water, they would find it neceſſary to fix their track-rope at the ſurface; if an oval figure, a little higher; if an oblong of great length, conſiderably higher; in order to obtain the greateſt velocity with a given force.

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out errors, and prevent the readers from being led into miſtakes, by adopting their ſentiments without proper diſcrimination.

The peruſal of ſuch books muſt, however, convince every reader, that the ſubject has been carefully attended to, in France, by philoſophers and men of ſcience; notwithſtanding which it ſeems far ſhort of perfection.

The difficulty and expence of accurately making a ſufficient number of Experiments, even on a ſmall ſcale, with the impoſſibility of doing it on a large one, has greatly obſtructed knowledge in this branch of ſcience.

To remove this difficulty as much as poſſible, muſt be an object of the firſt magnitude, in promoting the views of the Society. But to attempt it on too large a ſcale would not only exhauſt their funds, but greatly limit the number of Experiments, and diſcourage the Artiſts.

If ſuch conſiderations have any weight, would it not be proper for the Society, to offer a handſome Premium for the beſt plan of trying Experiments on a ſmall ſcale; ſuppoſe on Models of two, three, or four, feet long?

None ought to be tried on a large ſcale but ſuch as cannot be determined on a ſmall one, and that promiſe ſome improvement worthy of the expence.

As the apparatus for trying the degree of velocity, either in a direct or oblique line, muſt be different from that which is adapted for trying the comparative degrees of rolling and pitching, of proving whether a maſt will give way at the exact height of the metacentre found by calculation, &c. would it not be proper for the Society to give a Premium for each?

As Plans and Models may be formed in as great variety as the Artiſts have different ideas on this ſubject, the Society will probably find, that having them, in all caſes, made of wood, muſt be attended with a great deal of trouble, loſs of time, and difficulty of making the neceſſary alteration, eſpecially where they wiſh to add to any particular part, in order to know the different effect that ſuch addition will produce.

If any ductile matter, fit to make Models, of a proper denſity, and of a texture that would eaſily take and retain the form given to it, could

be

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If ſuch conſiderations have any weight, would it not be proper for the Society, to offer a handſome Premium for the beſt plan of trying Experiments on a ſmall ſcale; ſuppoſe on Models of two, three, or four, feet long?

Mr. Bouguer's "Traité du Navire" is a first-rate performance on the theory of floating bodies, and Mr. Duhamel's "Elements of Naval Archi-"tecture" deserve the same character, on the practical part of that science.

Translations of such classical works are not only necessary for the information of the English reader who does not understand French, but for explanation of the technical terms, even to those who do understand that language.

In treating on a subject of so various and complicated a nature as Naval Architecture, it is no wonder that even men of genius and ability should sometimes fall into errors. But it is a misfortune when the celebrity of their names makes others adopt their sentiments without proper inquiry. This, I believe, has been the case, in some instances, with those two authors.

Mr. Bouguer asserts, that the more canvas that can be spread on a ship, low down, it is the better; as he alledges it must have an equal effort in pushing her forward, and tend less to make her incline to one side. On this principle, he strongly recommends very square yards and low masts, although he acknowledges that seamen uniformly

uniformly affirm, that they find the contrary to be the cafe from experience. Strongly attached, however, to his own theory, he endeavours to prove what experience rejects.

It is not improbable that this error of Mr. Bouguer has been the caufe of many of the French fhips of war, and perhaps the English too, being too fquare rigged.

It is a common obfervation, and, I believe, in general a true one, that a top-gallant fail, fet alone in its proper place, will give a fhip a greater degree of velocity, in a light breeze, than a main fail, fet alone in its proper place, in the fame breeze, would do. Seamen account for this by faying, that there is more wind aloft than below, and that fails made of thin canvas draw better, in a light breeze, than fails made of thick canvas. But neither of thefe reafons, nor both taken together, are fufficient to account for this effect. The fame thing, I believe, will hold good if the experiment were made on a boat, or even on a model of three feet long.

I suspect it will be found (and it may eafily be tried by experiment), that a fmall impelling power, at the head of a maft, will force a fhip fafter

faster through the water than the same small power applied below, for this reason. The force applied at the head of the mast, which may be called the end of the lever, will act upon the ship in two different ways; to give her progressive motion, and to turn her upon her axis in a longitudinal direction. The tendency to turn on her axis will be opposed by the resistance of the fluid in which she floats; but that fluid, when the pressure upon it from the ship's inclination to turn on her axis is but small, easily yields, and by this means increases the progressive motion in a greater degree than an equal force would do if applied farther down upon the mast, or on a level with the water. But when the force or impulsion at the head of the mast is increased to a certain degree, this effect will cease; because the pressure on the fluid, from the ship's inclination to turn on her axis, is increased in proportion to the force applied at the mast-head, while the ship's progressive motion is resisted in proportion to the squares of her velocity.

If this be a just solution of the problem, it will follow, that short and broad vessels, which have the greatest tendency to turn on their axes in a longitudinal direction, will sooner lose the benefit to be derived from high sails by an increase

creaſe of the breeze, than long ſhips would do, for which reaſon they ſhould ſpread more canvas, in proportion, low down, and leſs aloft.

On the contrary; a long ſhip having much leſs tendency to turn on her axis in a longitudinal direction, will continue much longer than a ſhort one to benefit from very high ſails. She ought to have taller maſts and narrower yards, in proportion, than a ſhort and broad veſſel, particularly if ſhe has a long floor.

It may be proper to conſider whether this theory is ſupported by experience.

Cutters, from their great breadth in proportion to their length and ſhort floors, muſt have a great tendency to turn on their centres in a longitudinal direction. Experience ſhews that they find it neceſſary to ſpread a great deal of canvas low down; witneſs their long main booms, reaching far over their ſterns, and bowſprits kept on a level with the water. Luggers have often three, and ſometimes four, low maſts, with a view to ſpread a great deal of canvas low down: experience ſhews the good effect. But a long veſſel rigged in this manner, would neither ſail, work, nor keep

a good

a good wind; and it is for this reaſon that four maſts can never be put in a ſhip of a great length with the ſame advantages which three muſt produce.

Mr. Miller, of *Dalſwinton* in *Scotland*, who has made many Experiments on veſſels at a great expence, has not been able to do juſtice to his own Experiments, for want of a knowledge of the principles on which they ought to have been maſted. He built a long, flat, and narrow veſſel, and rigged her with four low maſts; ſhe did not anſwer, and it was impoſſible that ſhe ſhould: but had ſhe been properly maſted, ſhe would, in all probability, have anſwered his expectation. He built a veſſel upon two long, narrow, and quite flat bottoms: this conſtruction required rather tall maſts and narrow yards, but he rigged her with five low maſts; the conſequence was, that ſhe fell to leeward in the moſt moderate breeze with ſmooth water; ſhe could only ſail large, yet the conſtruction of the veſſel was not improper for keeping a wind.

The generality of the ſhips in the Coal-Trade are rather long, and particularly ſo in the floor; this conſtruction, according to the foregoing theory, ſhould anſwer beſt with tall maſts and

narrow

narrow yards; and Experience has taught them to rig their veſſels in this manner. Some people imagine that they adopt this method for convenience in narrow channels; but I have been aſſured by many of them, that they find their veſſels ſail better, and keep a better wind, when rigged in this manner.

There are a kind of Dutch veſſels, very long, flat, and narrow, which may conſtantly be ſeen in the river Thames, and which ſail and work very well. Experience has taught the Dutch to rig thoſe veſſels high and narrow; the foot of their ſails do not extend over more than two thirds of their length; they are galliot-rigged, with a ſmall mizen cloſe aft.

I have obſerved, in Holland, that they do not fix the rope by which they track their veſſels, on a line with the men or horſes which drag them, but conſiderably higher up on the maſt. But if they were to drag a globe through the water, they would find it neceſſary to fix their track-rope at the ſurface; if an oval figure, a little higher; if an oblong of great length, conſiderably higher; in order to obtain the greateſt velocity with a given force.

WHAT I have accounted for by the inclination which ſhips have to turn on their axis in a longitudinal direction, MR. BOUGUER has imputed wholly to the reſiſtance of the water on the ſhip's bow. If he had been right in this conjecture, it would have followed, that the more canvas ſpread low down, on every kind of veſſel, the better: Experience demonſtrates that he was wrong.

I FEAR I have ſaid too much on this ſubject for a hint, and, perhaps, too little to be perfectly underſtood. Yet I think this hypotheſis of ſo much conſequence, for regulating the ſize of maſts, yards, and ſails, that it was neceſſary to explain myſelf at ſome length, eſpecially as I believe the idea to be perfectly new. If I had it fairly proved by ſome ſimple and eaſily-made Experiments, I ſhould be inclined to give a Demonſtration, with ſome account of the advantages which may be derived from it, in maſting, and juſtly proportioning the ſize and ſhape of the ſails, &c. to the SOCIETY or to the Public.

SOME errors in Mr. DUHAMEL's book might likewiſe be pointed out, if this were the proper place; but it may be ſufficient to obſerve, that tranſlations of ſuch books ought to be attended with notes written by ſome able hand, to point

out errors, and prevent the readers from being led into miſtakes, by adopting their ſentiments without proper diſcrimination.

The peruſal of ſuch books muſt, however, convince every reader, that the ſubject has been carefully attended to, in France, by philoſophers and men of ſcience; notwithſtanding which it ſeems far ſhort of perfection.

The difficulty and expence of accurately making a ſufficient number of Experiments, even on a ſmall ſcale, with the impoſſibility of doing it on a large one, has greatly obſtructed knowledge in this branch of ſcience.

To remove this difficulty as much as poſſible, muſt be an object of the firſt magnitude, in promoting the views of the Society. But to attempt it on too large a ſcale would not only exhauſt their funds, but greatly limit the number of Experiments, and diſcourage the Artiſts.

If ſuch conſiderations have any weight, would it not be proper for the Society, to offer a handſome Premium for the beſt plan of trying Experiments on a ſmall ſcale; ſuppoſe on Models of two, three, or four, feet long?

None ought to be tried on a large ſcale but ſuch as cannot be determined on a ſmall one, and that promiſe ſome improvement worthy of the expence.

As the apparatus for trying the degree of velocity, either in a direct or oblique line, muſt be different from that which is adapted for trying the comparative degrees of rolling and pitching, of proving whether a maſt will give way at the exact height of the metacentre found by calculation, &c. would it not be proper for the Society to give a Premium for each?

As Plans and Models may be formed in as great variety as the Artiſts have different ideas on this ſubject, the Society will probably find, that having them, in all caſes, made of wood, muſt be attended with a great deal of trouble, loſs of time, and difficulty of making the neceſſary alteration, eſpecially where they wiſh to add to any particular part, in order to know the different effect that ſuch addition will produce.

If any ductile matter, fit to make Models, of a proper denſity, and of a texture that would eaſily take and retain the form given to it, could

be

be difcovered, it might perhaps be worthy of a Premium.

EXPERIMENTS fhould be firft made on bodies of the moft fimple figures, as they will be found the propereft for difcovering any fingle quality; and even where more qualities than one muft be united, ftill, the fimpler the figure, the better chance for being accurate in making the Experiment. But, where all the properties of a fhip are to be taken into confideration, as united in one body, the Experiment muft neceffarily be made with the Model of a Ship.

To illuftrate my meaning by an example: Suppofe it were required to know, whether a floating body partly immerfed, like a fhip, in a fluid, and fharp towards each end, would meet with a greater or lefs refiftance from that fluid, with the extreme breadth in the middle of the length, or toward one end of it; the moft fimple figure, on which to try this experiment, would be, a Model of a given length and breadth, fhaped like a wedge towards each end, and placed on edge in the water, having the fharp ends perpendicular to the horizon. This Model might be tried againft another made of the fame matter, and of equal weight, length, breadth,

and depth, but having the extreme breadth towards one end: the reſult of the Experiment would be much more to be depended on, than it would be, were the ſame Experiment to be tried on the Models of Ships; which being ſo complicated, matters foreign to the Experiment might affect the iſſue of it.

I HAVE been more particular on this ſubject, becauſe it has been uſual to try on the Models of Ships properties common to other floating bodies, which might have been better aſcertained on Models of a ſimpler ſhape.

MR. DUHAMEL gives the angle made by different ſhips bows, with a view to aſcertain the propereſt angle for dividing the fluid, by comparing the reputed character of the ſhips for ſailing: but nothing can be more vague; this angle can only be aſcertained by Experiments made on bodies of a ſimple figure: the reſult will hold good in ſhips.

IF the SOCIETY ſhall cauſe an artificial pond or baſon to be made for trying Experiments, it ſhould be broad enough to admit of a good many Models at the ſame time, that a comparative trial may be made of Models of equal weight, length, breadth,

breadth, and depth; the bodies of all being composed of the same homogeneous matter, the form alone being left to the artist. The centres of gravity might be regulated by a lead keel of equal size and weight affixed in the same manner to each.

A PREMIUM should be given to the Artist who produced the fastest sailer; a greater Premium if she likewise made the greatest resistance in a side direction, or kept the best wind; and the GRRATEST PREMIUM, if, to the other two properties, she made the greatest resistance to a rolling motion, and soonest became at rest.

Of all round shapes, a globe, having a bias, or its centre of gravity in a different point from the centre of the sphere, must be the shape the most liable to roll long and deep in any direction; and for the same reason, of all long bodies, a cylinder must be the most liable to roll long and deep from one side to the other. Ships ought not to roll long and deep, and therefore ought not to be of this shape, unless some advantage arises from it of still greater importance; which I believe is not the case. Notwithstanding this consideration, many of the largest British ships of war (not copied from French models) have their midship-

frames very near a half circle; the consequence is, that they must either roll very deep, or bring the centre of gravity too high for preserving a proper degree of stability when under sail; ships ought therefore to have a pretty straight futtock: or, if the draught of a midship-frame, which I have the honour to send you herewith, is on a proper plan, they ought rather to have a curve in the opposite direction. I have shewn this draught to Mr. RULE, the Master-shipwright of *Woolwich-yard*, who approves of the plan, and says, ships might easily be made of this shape, by a little addition to the outside, without requiring additional knee-timber for forming the angle between the floor-timbers and the futtocks.

THE vessel was built in the *East-Indies*, and, I was told, not only sailed remarkably well, but did not roll like other ships; which I can very well believe. I never saw the draught of any other part of her body, but I have been informed that Mr. MILLER, of *Dalswinton*, has the whole *.

To procure that, and to learn her properties and defects from good authority, as she deviates so much from the common form, may be an object worthy of the SOCIETY.

* There is a very accurate Model of this Vessel at the East-India House. See the Plan at the End of the Letter.

THE

The common argument in favour of a round futtock is, that it increaſes the capacity, and makes the ſhip more buoyant. But this property ſhould rather be obtained by increaſing her length, or continuing a number of her frames a-midſhips of an equal area.

If a ſhip of 64 guns were to be cut in the middle of her extreme breadth, and made as long as a ſhip of 74 guns, having her maſts and yards properly proportioned, ſhe would carry her guns higher than ſhe did before, and, probably, ſail faſter than any other two-decked ſhip in the ſervice.

The idea that ſhips ought immediately to taper or become narrower from the midſhip bend or frame, that the cloſing of the water behind them may puſh them forward, is a vulgar error; that the ſhape of Fiſhes ought to be copied in ſhips, is another; as the analogy does not hold good. Yet thoſe two ideas have occaſioned great blunders in Naval Architecture.

I need not tell you, that an immenſe expence has been incurred by ſpringing and rolling away maſts. A very great part of this might have been ſaved, if the proper forms had been given

to

to the ſhips bottoms and upper works; the former to reſiſt rolling, and the latter to bring the metacentre (as Mr. BOUGUER calls it), or the changing-centre, as the name implies, high up upon the maſt when the ſhip rolls deep; which is to be done by making the extreme breadth ſome height above the water-line, and continuing it as high as the ſhip is likely to roll deep. A Cutter, which ſpreads or continues to increaſe her breadth to the top of her gunnel, would never roll away her maſt; and it would be a very eaſy matter to make the lower maſts of frigates, or even two-decked ſhips, very ſecure againſt it. But moſt of our large ſhips are of ſuch a con-ſtruction as to place the metacentre a little above the deck, when they roll deep, all above acting as a lever to make the maſt give way at this place: experience ſhews that it has too often the effect. All Builders of large ſhips, or rather thoſe who form the draughts of them, as well as Maſt-makers, ſhould be maſters of this ſubject.

I BEG leave to ſay a few words on the poſition in which maſts ought to ſtand, in order to favour the trim of the veſſel.

ACCORDING to the theory which I have laid down, that ſhort and broad veſſels, being apteſt

to

to turn on their centres in a longitudinal direction, require to have the impulſe which drives them forward, eſpecially when they ſail faſt, placed low down; it will follow, that the maſts of ſuch veſſels ſhould ſtand in a direction favourable for producing ſuch an effect. Short and broad veſſels which have but one maſt, or even when they have two, that which is placed near the centre of the veſſel ſhould, for this purpoſe, rake much aft. Long ſhips with long floors ſhould have them upright.

EXPERIENCE favours the theory.

As it is neceſſary to calculate with as much preciſion as poſſible, even from the draught of a ſhip of war intended to be built, the weight of the column of ſalt water that ſhe will diſplace, in order to aſcertain from thence, with as much preciſion as poſſible, the height that ſhe will carry her lower-deck ports out of the water; for this purpoſe it is neceſſary to know, with the greateſt exactneſs, the weight of a cubic foot of ſalt water. It has been often tried, but both French and Engliſh authors differ a little from each other on this ſubject. Perhaps the SOCIETY ſhould be at ſome pains to have it accurately determined: the method which MR. DUHAMEL uſed for that purpoſe may be found in the Preface to his book.

NOTHING

Nothing has tended more to impede the extenſion of the knowledge of the Theory, or Scientific Part, of Naval Architecture, among thoſe Profeſſional Men in this Country who riſe to fill the higheſt offices in that department, than the very contracted mode of their education in the King's Yards, where they certainly learn to become excellent Practical Ship-builders, but have, in general, a very limited knowledge of the Theory on which it is founded. As it is no part of their duty to form Draughts to build from, it becomes a ſmall part of their ſtudy. The conſequence is, when they come to fill that department where it is their duty, a want of ſkill to make improvements obliges them to copy the errors of their predeceſſors. This conveys no reflection on the gentlemen themſelves, but ſolely on the mode of their education.

With a view, I ſuppoſe, to remedy this evil, the Society have propoſed to "aſſiſt young perſons in the attainment of this moſt uſeful art," and even to aſſiſt in forming an Academy for that purpoſe.

In either caſe, the principal parts of education will be:

ARITHMETIC in all its branches, particularly as it relates to Menſuration:

ALGEBRA:

DRAWING, eſpecially as it relates to delineating ſhips, or the parts of which they are compoſed, upon a plane:

GEOMETRY:

TRIGONOMETRY:

CONIC SECTIONS, and MATHEMATICS in general, particularly as they relate to Naval Architecture:

EVEN CIVIL ARCHITECTURE ſhould be taught, as far as it relates to all buildings neceſſary in the King's Yards:

ENGINEERING, for the ſame reaſon, and MECHANICS, eſpecially as they relate to Naval Engineering:

FORTIFICATION, as it may relate to ſecuring yards, &c. from attacks by ſea, floating batteries, &c.

I HAVE

I HAVE omitted thofe branches taught in the Yards, as part of the education fhould be there, and part at fea.

I SHALL only add, that, as Men of Science are not always men of wealth, the SOCIETY may, perhaps, find fome advantage from admitting fome HONORARY MEMBERS, for merit only; twenty pounds worth of information being worth twenty pounds in money.

I have the honour to be,

SIR,

Your moft humble fervant,

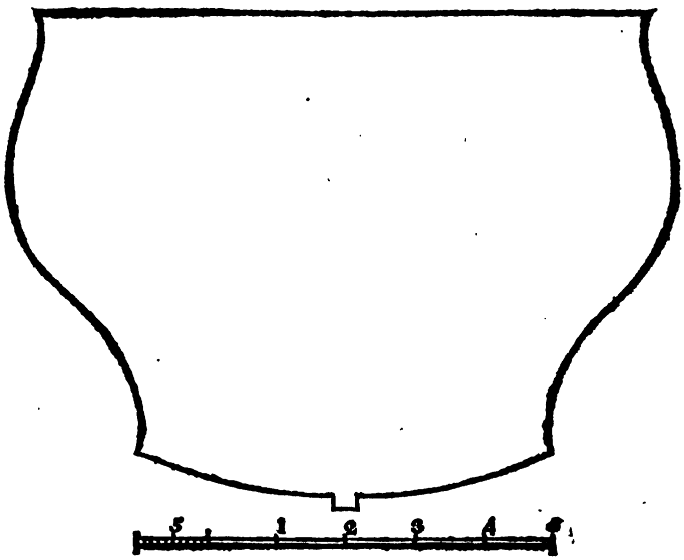
CHARLES PATTON.

Woolwich.

MIDSHIP-FRAME of the SNOW CORNWALLIS of 300 tons *.

LENGTH 84 feet.

BREADTH 27 feet.



* Referred to, in page 40.

ARTICLE III.

TO THE SECRETARY, &c.

SIR, *Carlscrona, January the* 3d, 1792.

IN confequence of a requifition in an *Addrefs to the Public, &c.* for a new method of afcertaining a fhip's burthen, by which the three principal dimenfions of a fhip muft be obferved, I have at my leifure-hours and by way of amufement undertaken that problem (as variety of ftudy is pleafing). Regardlefs of the premium, it would afford me the greateft pleafure, if this my undertaking fhall give any fatisfaction.

IT contains two different ways of calculating a fhip's burthen: the one I have confidered ufeful when contracting for the building of a fhip; and the other when the queftion is, What quantity of weight in goods a veffel pofitively can carry?

I ALSO annex the ufual method of meafuring fhips in Sweden. Neither of thefe methods do anfwer the requeft of the Society, as I cannot by any

any other means find out how to exprefs a fhip's depth, but relative to the breadth, length, or both, from which the depth neceffarily will be loft in the expreffion. You will find more objections pointed out in the operation. A houfe may be built two, three, or four ftories high, and each ftory as high as you pleafe, without regard to length or breadth, but with fhips it is not fo. A frigate will never be a three-decker.

I have the honour to be, Sir,

Your humble Servant,

(Signed) F. H. af CHAPMAN.

ON THE METHOD OF ASCERTAINING A SHIP's BURTHEN.

IN England it is ufual to multiply the length of the keel * by the extreme breadth of the fhip, and this again by half the breadth (inftead of by the depth), the product of which divided by 94 is then deemed the veffel's tonnage. This method might do tolerably well, although it does not include the depth; becaufe it is not to be fuppofed, that any one fhould be fo abfurd, for a

* For tonnage.

little gain, to give the veſſel more depth than would anſwer the other two dimenſions, ſince it might render the ſhip uſeleſs. But on examining into the manner by which the length of the keel* is aſcertained, we ſhall find the above method highly erroneous. For the rake of the ſtem is reckoned $\frac{3}{5}$ of the breadth, and for the rake of the ſtern-poſt $\frac{1}{8}$ † of the breadth. When theſe two are added together, and ſubſtracted from the length of the veſſel on the lower deck, then is the remainder ſaid to be the length of the keel for tonnage.

Let the veſſel's length on the lower deck, or at the height of the wing tranſom $= L$; the ſhip's breadth midſhips $= B$. Now $\frac{3}{5}+\frac{1}{8}=\frac{29}{40}$; the length of the keel is therefore $= L - \frac{29}{40}B$, which multiplied by the breadth, and again by half the breadth, and divided by 94, gives

$$\frac{\overline{L - \frac{29}{40}B} \times \frac{B^2}{2}}{94}$$

, which is then the ſhip's tonnage.

If this is made a Maximum, then ſhould the ſhip's tonnage be greateſt when the breadth is $\frac{80}{87}$ of the length (L); and if the ſame quantity

* For tonnage.

† In Merchants' ſervice 3 inch.
In King's ſervice — $2\frac{1}{2}$
for every foot the wing tranſom is above the upper-edge of the rabbet.

is

little gain, to give the veſſel more depth than would anſwer the other two dimenſions, ſince it might render the ſhip uſeleſs. But on examining into the manner by which the length of the keel * is aſcertained, we ſhall find the above method highly erroneous. For the rake of the ſtem is reckoned $\frac{3}{5}$ of the breadth, and for the rake of the ſtern-poſt $\frac{1}{8}$ † of the breadth. When theſe two are added together, and ſubſtracted from the length of the veſſel on the lower deck, then is the remainder ſaid to be the length of the keel for tonnage.

Let the veſſel's length on the lower deck, or at the height of the wing tranſom $= L$; the ſhip's breadth midſhips $= B$. Now $\frac{3}{5} + \frac{1}{8} = \frac{29}{40}$; the length of the keel is therefore $= L - \frac{29}{40} B$, which multiplied by the breadth, and again by half the breadth, and divided by 94, gives

$$\frac{\overline{L - \frac{29}{40}B} \times \frac{B^2}{2}}{94}$$

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* For tonnage.

† In Merchants' ſervice 3 inch. } for every foot the wing tranſom is above the upper-edge of the rabbet.
In King's ſervice — $2\frac{1}{2}$

is

is made $= 0$, then the ſhip cannot carry any burthen when the breadth is $\frac{40}{29} L$. This I ſhall fully illuſtrate by the following Figure *.

SUPPOSE AL or 100 feet to be the veſſel's length; AB, AB, AB, or 10, 20, 30, &c. different breadths to the ſame length (100). If then the veſſel's tonnage is calculated as above for every different breadth, then muſt all the correſponding ordinates BC, BC, BC, &c. expreſs the ſhip's tonnage. By this Figure it appears, that when the breadth is 92 feet, or $\frac{80}{87}$ of the length, then is the ordinate BC longeſt, or then the veſſel carries moſt weight. But as the veſſel becomes broader, the burthen decreaſes; ſo that when the veſſel becomes 138 feet in breadth, or $\frac{40}{29}$ of its length, then it cannot carry any burthen: and if its breadth be greater, it will carry leſs than nothing. All which ſhews that the rule is erroneous; nor can there be any-thing more abſurd than to ſuppoſe, that the part of this Figure which is within the ticked line, contains ſomething, but that the whole contains nothing. Theſe errors, however, are not very apparent, becauſe the breadth of a ſhip of 100 feet in length, for inſtance, ſeldom varies more than between 25 and 28 feet, and ſo on in proportion with reſpect to larger or ſmaller ſhips. Never-

* See Plate annexed.

thelefs, although this variation is not great, ftill it is productive of a greater number of tons in a broad than in a narrow veffel, though the product of the length and breadth fimply may be alike in both.

But it is the Builder that makes an eftimate of the building-expences of a fhip, and this coft is in proportion to the product of its length, breadth, and depth; the fhip may be broader or narrower in proportion to its length, when the product is alike, the price is nearly the fame; but as it appears eafier to judge of the difference in the price when fixed on the number of tons, which is done by dividing the fum that the fhip cofts by the number of tons that are produced by the rule adopted, by which each ton of a broader fhip will coft lefs than each ton of a narrower, the buyer therefore gives the preference to a broad fhip, as he imagines that he gains by it, not knowing of the circumftance that lies hid in the erroneous rule. If therefore what is thus calculated is to maintain the name of tons, then every ton is fmaller in a broad veffel than in a narrow one. In confequence of this he neither gains nor lofes by his choice, but it is attended with the ill confequence of building

building ſhips too broad in proportion to their length.

I AM informed that it has been thought profitable to build ſhips extremely broad, and immediately, or ſome time after, put them into dock to be lengthened; but how far it is profitable, calculation will ſhew, when the coſt of lengthening the ſame is known. It is therefore neceſſary to put a ſtop to ſo pernicious a practice, which ſhould be done by forming another rule. The coſt of a ſhip is nearly in proportion to its outer ſurface multiplied by the thickneſs of its ſides; but as this thickneſs may be conſidered in proportion to one of the dimenſions, ſo it may be judged that the product of length, breadth, and depth, gives the proportional coſt. Nevertheleſs a difficulty attends this, namely, the length and breadth can preciſely be fixed, but the height or depth not altogether ſo eaſily. For inſtance, if I uſe the depth of the hold as the third dimenſion, it may happen, in conſequence of the cargo which the veſſel is to carry, that the lower deck has been laid a foot higher or lower, although its length, breadth, and the whole of the height, remain the ſame without any alteration; the expence of building equally the ſame, as alſo the burthen; but the difference of the height of the deck increaſes or decreaſes the

 product,

product, and consequently the price in proportion. In like manner it acts with regard to the upper deck. Should the height of the vessel from the kelson to the gun-wale be taken as the third dimension, it will be found to vary as much as the former. For example, the gun-wale might be made half a foot or a foot less in height, and that added to the gun-wale after the ship is built, which of course would make it cost less than if that height was included in the calculation. If that part of the ship which is immersed when loaded should be taken as the third dimension, then would it depend on how high the water-line stands marked on the draught up to which the ship ought to be loaded, which might also be higher or lower. It is therefore better to institute a rule, which, although not totally exact, is still determined, and not subject to disputes or confusion.

I SHALL therefore propose, that the ship's height or depth should be taken in a proportion to the two precise or determined dimensions, namely, as the square root of the product of the length and breadth. If now the length and breadth be expressed by L and B, then must the depth be in a certain proportion to $\overline{L\,B}\,^{\frac{1}{2}}$, without regarding how great that quantity may be. This ought

ought to be multiplied by the length and breadth, that is, the number of tons shall be as $\overline{LB}^{\frac{1}{2}} \times BL = \overline{LB}^{\frac{3}{2}}$. This expression is a solidity or content which characterizes the size of the ship, in which two of the principal dimensions are equally involved. To make practical use of this expression for the purpose of determining a ship's burthen in tons, and at the same time that it sometimes agrees with the old method, it will be necessary to find what proportion the breadth bears to the length, agreeably to the old method of determining the tonnage when the contract has been equally beneficial. Suppose the breadth to have been $\frac{26\frac{1}{2}}{100}$ of the length, or the length to be 100 feet when the breadth is 26 ½ feet. According to the old method,

$$\frac{\overline{100-\frac{20}{40}\times 26{,}5}\times \overline{\frac{26{,}5}{2}}^{2}}{94} = 301{,}78 \text{ tons};$$

therefore

$$\frac{\overline{100\times 26{,}5}^{\frac{3}{2}}}{x} = 301{,}78; \text{ where } x = 452.$$

In consequence of which the size of the ship in tons always ought to be expressed by $\frac{\overline{LB}^{\frac{3}{2}}}{452}$

The depth of the ship is not mentioned in this expression for the reason already alledged, that

no one is ſuppoſed to give his ſhip a diſproportionate depth, as the lengthening of it will not remedy the evil. To ſhew how this expreſſion repreſents itſelf in a Figure compared to the former,

Let the quantity of tons $= T$. Now $\frac{\overline{LB}^{\frac{3}{2}}}{452} = \frac{L^{\frac{3}{2}}}{452} \times B^{\frac{3}{2}} = T$; let L be conſtant, then is the expreſſion a parabola whoſe vertex is in A, axis $A\,E$, ordinate $A\,B = B$, abſciſſa $B\,D = T$, the parameter $= \frac{452}{L^{\frac{3}{2}}}$, the exponent $= \frac{3}{2}$, and the equation will be $\frac{L^{\frac{3}{2}}}{452} \times B^{\frac{3}{2}} = T$.

If the ordinates $A\,B$, $A\,B$, $A\,B$, &c. $=$ 10, 20, 30, &c. expreſs different values of B, theſe will produce the correſponding number of tons (T) $= B\,D$, $B\,D$, $B\,D$, &c. This ſhews the error of the old method, becauſe the number of tons with 30 feet breadth is 374½, and according to the new rule 363½, that is, 11 tons too much, and with 20 feet breadth according to the old rule 182, but by the new rule 198, which is 16 tons too little. All this is only to characterize the ſize of a ſhip, the better to judge how to contract for the building. I am confident, that

if

if the above expreſſion $\frac{\overline{LB}^{\frac{3}{2}}}{452}$ is adopted for the propoſed purpoſe, it will never be attended with any ill conſequence; except when in adjuſting this matter it may happen that the diviſor 452 becomes ſubject to ſome alteration.

It is impoſſible to aſcertain a ſhip's actual burthen from the principal dimenſions, that is, by the product derived from length, breadth, and depth, becauſe two ſhips may be of an equal length, breadth, and depth, but greatly differing with regard to tonnage, owing to the greater or leſs ſharpneſs of the bottom, difference in the upper works, rigging, and ſo forth: another method is therefore to be ſought.

To aſcertain a ſhip's actual burthen, there is another method beſides that of determining the ſolid contents of that part of the ſhip's body which by the loading is to be immerſed, becauſe the weight of the burthen which it can carry is equal to the weight of that volume of water which it forces from under it.

It depends therefore on finding the ſolid contents of that part of the ſhip's body which is between the water-line when empty, and the

water-

water-line when loaded. If that part of the ſhip which is to be ſunk down had the form of a parallelopiped, or if at both ends equally as broad as midſhips, then nothing further would be to do than to multiply the length by the breadth, and this again by the height which is to be immerſed by the loading; which product multiplied by 63lb. (which I ſuppoſe to be the weight of a cubic foot of ſalt water), and divided by 2240 lb. (which I believe to be the weight of a ton), would give the ſhip's burthen in tons. But a ſhip never has ſuch a form as to be compared to a parallelopiped, but is roundiſh at the ends, and narrower downwards, and therefore leſs.

To diſcover this leſſening or ſhape cannot be done otherwiſe than by procuring draughts of ſhips that are more or leſs ſharp. On theſe draughts draw two water-lines, the one to ſhew when ſhe is loaded, and the other when empty, and on conſidering the ſhape of the ribs it will be eaſy to find the ſolid contained betwixt the two lines. It is alſo neceſſary at the ſame time to know the area of theſe two water-lines. If the length of the upper water-line is $= l$, its breadth midſhips $= b$, and that ſpace or depth of the ſhip which the loading ſhall immerſe $= d$, let the

the product of l, b, d, in each draught be $= P$, and the real solid contents between the two water-lines, as found by those draughts, $= Q$; then is $\frac{Q}{P}$ to be used as a coefficient for the measuring of all ships. Arrange these $\frac{Q}{P}$ (which are discovered by the draughts under certain classes, and begin with the fullest in this manner.

Classes	1	2	3	4	5	6	7	8	9	10
Q	1	1	1	1	1	1	1	1	1	1
P	1,097	1,125	1,153	1,181	1,209	1,237	1,265	1,294	1,322	1,350

I have here fixed on ten different classes, but six or seven might have been enough, as it is very difficult for the eye to discern these differences to a nicety. The King's * order respecting the measuring of ships will explain my meaning.

To obtain, in consequence of this, a ship's burthen in tons, it is requisite to multiply the value of $\frac{Q}{P}$ by $\frac{63}{1,240}$ $\left(\frac{1}{35,555}\right)$, which makes the coefficient for the first class $\frac{1}{1,097} \times \frac{1}{35,555} = \frac{1}{39}$, for the second class $\frac{1}{1,125} \times \frac{1}{35,555} = \frac{1}{40}$, and so on, which furnishes a divisor for all the ten classes, viz.

Classes	1	2	3	4	5	6	7	8	9	10
Divisors	39	40	41	42	43	44	45	46	47	48

by which $L\ B\ D$ (of the ship that is to be

* Of Sweden.

meaſured) is to be divided, and the diviſor to be choſen according to the fulneſs or ſharpneſs of the ſhip.

EXAMPLE.

Suppoſe that a ſhip's length by the upper water-line from its two extremes is = 132 feet = L, and its extreme breadth cloſe under the main wale = 34 feet = B, and that part of the height which is to be immerſed by the loading = 6 ½ feet = D.

SUPPOSE alſo that this ſhip, in conſequence of its fulneſs, is conformable to the fifth claſs; the burthen is then $\frac{132 \times 34 \times 6\frac{1}{2}}{43} = 678\frac{18}{43}$ tons. If this veſſel had been ſomewhat ſharper, ſo as to be conſidered of the ſixth claſs, its diviſor ſhould then be 44, which would have made the burthen 663 ton; and if immerſed more than 6 ½ feet, the burthen would have increaſed in like proportion. Furthermore refer to the annexed Ordonnance for meaſuring of ſhips.

Jan. 3, 1792.

EXTRACT

EXTRACT OF THE KING'S ORDER RESPECTING THE MEASURING OF SHIPS.

PRINTED IN THE YEAR 1778.

I.

ALL Menſuration is to be done by the Swediſh foot; and the veſſel's burthen to be marked down in laſts, each to be conſidered in weight equal to eighteen ſkeppund iron weight, or 18 times 320 lb. Swediſh.

II.

THE veſſel's length to be meaſured on the higheſt water-line when loaded from the fore part of the rabbet of the ſtem to the aft part of the rabbet of the ſtern-poſt.

III.

THE ſhip's breadth is to be meaſured in midſhips without-board cloſe up to the main wale.

IV.

THE height to be meaſured from the ſurface of the water without-board, up to that mark which determines how deep the veſſel will ſwim when completely loaded.

* Of Sweden.

V. MUL-

V.

Multiply theſe three admeaſurements by each other, and divide the product by 112, ſhould the veſſel be of the uſual ſhape, and neither too full nor too ſharp at the ſtem and ſtern: if the veſſel is ſharper the diviſor muſt then be greater, and if fuller a little leſs, as pointed out to the meaſurer in the ſeparate inſtructions.

VI.

If the neceſſary proviſion, water, wood, and utenſils for the voyage, ſhould not be on board when the ſhip is meaſured, and which weight does not actually belong to the burthen that the veſſel is meaſured to carry, then it is neceſſary to deduct from the calculated burthen of laſts as follows:

On a veſſel of 350 laſts is allowed 11 laſts deduction;
300 ———————— 9 $\frac{1}{2}$ ditto;
250 ———————— 8 ditto;
200 ———————— 6 $\frac{1}{2}$ ditto;
150 ———————— 5 ditto;
100 ———————— 3 $\frac{1}{2}$ ditto;
80 ———————— 2 ditto;
60 ———————— 1 ditto;
40 ———————— $\frac{2}{3}$ ditto;

and ſo on in proportion in ſuch veſſels as are not coincident with the above denomination; but ſhould any of the articles mentioned be on board, the deduction will be leſs in proportion.

VII. Should

VII.

Should one or more of the necessary cables not be on board when the vessel is measured, then the following deductions are to be made:

For an 18 inch cable		25 skeppund;	
17 ditto	——	22 ditto;	
16 ditto	——	20 ditto;	
15 ditto	——	18 ditto;	
14 ditto	——	16 ditto;	
13 ditto	——	14 ditto;	
12 ditto	——	12 ditto;	
11 ditto	——	10 ditto;	
10 ditto	——	8 ditto;	
9 ditto	——	6 ditto;	
8 ditto	——	5 ditto;	
7 ditto	——	4 ditto;	
6 ditto	——	3 ditto;	
5 ditto	——	2 ditto;	
4 ditto	——	1 ditto.	

All is iron weight.

VIII.

Should one or more anchors be wanting, their weight is to be deducted in proportion to the vessel's size.

IX.

If the vessel's sails are not on board, the deduction from its number of lasts is to be as follows:

On

On a vessel of 350 lasts	14 skeppund;	
300 —	13 ditto;	
250 —	12 ditto;	
200 —	11 ditto;	
150 —	10 ditto;	
100 —	9 ditto;	
80 —	8 ditto;	
60 —	6 ditto;	
40 —	3 ditto;	

All iron weight;

and less in proportion when fewer sails are wanting.

X.

If the vessel is built to carry guns constantly, and that none, or part of them only, are on board, then a deduction for cannon, carriages, gun-tackling, &c. is as follows;

For a 12 pounder with its requisites	13 skeppund;
8 —	10 ditto;
6 —	8 ditto;
4 —	6 ditto;
3 —	$4\frac{1}{2}$ ditto;
2 —	$3\frac{1}{2}$ ditto;

All iron weight.

XI.

Should the vessel, when measured, have its ballast on board, then that weight must be ascertained, and added to the number of lasts found; but it is best to measure the vessel before it is ballasted, if convenient.

XII. The

XII.

The ſhip's meaſurer having duly conſidered the foregoing circumſtances, and in conſequence thereof aſcertained the veſſel's proper tonnage to a certain depth, fore and aft, when loaded, he is then to make an entry of the foregoing in the Book of Admeaſurements given him for that purpoſe, which book is run through and ſealed with the ſeals of the Court of Aldermen and the Cuſtom-Houſe: he is alſo to enter the number of laſts requiſite to immerſe the veſſel, progreſſively, from one foot at the beginning of the loading till when completed, and alſo to ſet down how deep ſhe lies fore and aft when unloaded.—He is to deliver copies of the ſame with ſpecific calculations, admeaſurements, and deductions, of all this, to the Court of Aldermen and Board of Cuſtoms within two days after meaſured, that the ſame may be examined and ſanctioned.

XIII.

Should there be any-thing to be obſerved by the parties, the ſame muſt be made known at the reſpective places, within eight days after the delivery, at the expiration of which time the ſhip's regiſter will be made out, and the approved cal-

culation of the meaſurer annexed to the ſame, and to be kept on board as the ſhip's inventory. The ſame is to be entered with all the calculations in bound paged books, and alphabets thereunto annexed, in the Court of Aldermen and at the Cuſtom-houſe.

XIV.

Whereas veſſels when old and ſoaked through by the water, cannot carry ſo much as when new, it is therefore requiſite to meaſure the veſſel every tenth year in like manner as expreſſed in the twelfth ſection.

INFORMATION FOR THE SHIP's MEASURER.

I.

INSRUCTIONS for the ſhip's meaſurer for the better performance of his duty.

He is to provide himſelf with a five or ſix-foot rod, and a two-foot rule, which are to be divided into decimals, that is, each foot into ten parts or inches, and each inch into ten parts or lines: he

must

must also be provided with a broad tape of about 80 alnar or 160 feet long, and about an inch wide; which, being painted on both sides with oil-colour, is to be marked with feet, and may for conveniency be wound up on a roller.

THE rod and rule are divided into decimals on account of their ease in calculation, as the number of feet, inches, and lines are multiplied by each other as integers, and the decimals are separated from the integers by means of a comma; which by instruction and a little practice is made plain.

HE must also be provided with a plummet of about two pounds weight, and a line of four or five fathoms in length.

WHEN the length and breadth of the vessel are taken, it is necessary to measure that part of the height which by the loading is to be immersed.

1. OBSERVE how many feet and inches the vessel lies deep all around when quite empty, and call that place the discharging line.

2. ASCERTAIN a certain height on the stem and stern-post, to which it is to be immersed when loaded, and term that place the loading line.

It is safest, or most accurate, to measure these heights with the rod, as the numbers marked down on the stem and stern are not always to be depended on; besides, foreign measures differ from ours.

3. A vessel being very seldom so situated that the distance between the discharging line and the loading line is alike fore and aft, therefore the two distances are to be added together, and that halved, which shews to what depth the whole body will be immersed when loaded, and which I shall term immersing height.

As the tonnage or number of lasts depends on that column of water which the vessel occupies in consequence of the pressure of the loading, therefore the solid contents of that part which is between the discharging line and the loading line must be ascertained.

If the vessel is square-built, that is, at both ends of the same breadth as midships, its cubical contents would then be found, by multiplying the length, breadth, and height to be immersed, by each other; the product multiplied by 62 lb. which is about the weight of a cubic foot of water in our ports, would give the number of pounds which

which ſuch a veſſel could carry; and this product divided by the number of tons reckoned to a laſt, that is, 18 times 320 lb. or 5760, would give the burthen in laſts.

To ſhorten this operation, divide 5760lb. by 62lb.; the quotient 92,9, or 93, may be adjudged a general diviſor for larger or ſmaller veſſels, when the length, breadth, and the immerſed height, are multiplied by each other.

But as ſhips or veſſels never are thus ſhaped, but roundiſh at the ends, and more ſharp at the diſcharging line than at the loading line, 93 cannot always ſerve as a proper diviſor, becauſe the calculation would then give a greater number of tons than the veſſel could carry; therefore the diviſor muſt be greater, and greater for ſharp than full veſſels.

The diviſor for the ſolid contents cloſe by the loading line muſt alſo be leſs than the diviſor uſed for the whole immerſion, becauſe a veſſel is always fuller at the loading line; and the diviſor for the ſolid contents cloſe by the diſcharging line muſt be greater than the diviſor which is uſed for the whole depreſſure, becauſe a veſſel is always ſharper at the diſcharging line

than at the loading line; therefore this method of meaſuring depends on a proper diviſor, ſuitable to the veſſel's more or leſs fullneſs at its ends.

1ſt *Claſs*.

HAVING made calculations from the draughts of ſundry ſhips, and trial on ſeveral veſſels, it has been found that in full-built veſſels, which have nearly the ſame breadth all the way, and are very full at the ends, the diviſor for the number of laſts for the whole immerſed height is to be 104; for the number of laſts near to the loading line 98; and for the number of laſts near to the diſcharging line, the diviſor is to be 108.

2d *Claſs*.

GERMAN Galliots and Galleaſſes, and ſome Daſſar yachts and Engliſh colliers, which generally have a long and continued breadth, and are very full at both ends, the diviſor for finding the number of laſts for the whole immerſed height muſt be 108; to find the number of laſts near the loading line, 99; and to find the number of laſts near the diſcharging line, the diviſor muſt be 114.

3d *Class.*

COMMON English barks and cats, and other vessels which are similar with regard to fulness, the divisor for the whole immersed height is 110; by the loading line 100; and by the discharging line 117.

4th *Class.*

FOR vessels in common, which are neither too full nor too sharp, as are generally our Mediterranean traders, especially the larger sort, the divisor for the immersing height is 112; by the loading line 101; and by the discharging line 120.

5th *Class.*

VESSELS which are a little sharper, and yachts in common, which are rather broad, but their sides all along possessing a deal of curvity and not very sharp at the ends, the divisor for the whole immersing height is 115; by the loading line 102; and by the discharging line 124.

6th *Class.*

VESSELS that are sharper than in common, the divisor for the whole immersing height is 118; by the loading line 103; and by the discharging line 128.

7th *Class*.

Vessels which are very sharp fore and aft, as are our brigantines and schooners, the divisor for the whole immersing height is 122; by the loading line 104; and close by the discharging line 133.

To facilitate the foregoing rules, I shall here give the divisors at one view in the following order:

	DIVISORS		
To what Class belonging.	For the whole Immersing Height.	Number of Lasts close to the Loading Line.	Number of Lasts close to the Discharging Line.
1	104	98	108
2	108	99	114
3	110	100	117
4	112	101	120
5	115	102	124
6	118	103	128
7	122	104	133

Mode of applying the foregoing, viz.

Suppose a vessel's extreme length from stem to stern by the loading line to be 132 feet, its extreme breadth without, close under the lower wale, 34 feet, or depth when empty aft 11,25 feet, and fore 9 feet, but that the loading line or depth

depth in the water when loaded = 19 $\frac{25}{100}$ feet, and fore = 18 feet; subtract 11,25 from 19,25, remains 8 feet; subtract 9 from 18, remains 9 feet. 8 and 9 added together make 17, half of which, 8,5, is the whole immersing height which is to be immersed in the water.

Multiply the Length	134
by the Breadth	34
	536
	402
	4556

Multiply this - - -	4556
by the Immersing Height	8,5
	22780
	36448
	38726,0

If the vessel should come under the denomination of the 4th Class, with regard to fullness and sharpness, then the divisor for the whole immersing height is 112:

$$
\begin{array}{l}
112)38726(345\tfrac{86}{112}\text{ lasts;} \\
\quad 336 \\
\quad \overline{\;512} \\
\quad\; 448 \\
\quad \overline{\;\;646} \\
\quad\;\; 560 \\
\quad \overline{\;\;\;86}
\end{array}
$$

which

which is what the veſſel would carry, if every-thing belonging to the veſſel and crew were on board. But if on examination it is found that the proviſion, water, and wood for the voyage, are wanting, as alſo a 16 inch cable, the beſt bower of about 9½ ſkeppund, and eight 4 pounders with their carriages, &c. and all the ſails;

The different weights of theſe articles, agreeable to regulation, are

For Proviſion, water, &c.	-	-		$10\frac{1}{2}$ laſts;
Cable	-	20 ſkeppund;		
Anchor	-	$9\frac{1}{2}$ ditto;		
Eight four-pounders	-	48 ditto;		
Sails	-	14 ditto;		
Skeppund		$91\frac{1}{2}$	- is -	$5\frac{8}{100}$ laſts;
			Together	$15\frac{58}{100}$

Laſts aſcertained	-	$345\frac{86}{112}$
		$15\frac{58}{100}$
Remain about		$330\frac{1}{4}$ laſts;

which is what this veſſel can carry when deep,

Aft $19\frac{1}{4}$ feet
and Fore 18 ditto.

To find how many laſts are requiſite to ſink the veſſel down at the beginning, or at the cloſe of the loading;

The diviſor for the diſcharging line, or when the

the vessel lies empty, is for the 4th Class put down to 120; and for the loading line 101.

The length and breadth multiplied by one another, divide by 120;

120)4556(= 38 lasts;
36
—
95

therefore 38 lasts are requisite to sink the vessel down one foot at the commencement of the loading,

Divide also 4556 by 101.

101)4556(=45 $\frac{11}{101}$ lasts;
404
—
516
505
—
11

therefore 45 $\frac{1}{10}$ lasts are requisite to sink the vessel down one foot at the close of the loading, or when down near to the loading line.

Suppose that this ship or a similar one has the bottom so constructed, that it cannot lie straight on the water without ballast, or some other weight in the hold, it must then be measured when the same is on board; and suppose that it then lies deep aft 13,38 feet, and fore 10,79 feet, its depth fore

fore and aft when loaded as before, therefore 13,38 from 19,25 is 5,87, and 10,79 from 18 is 7,21: add 5,87 and 7,21 gives 13,08, the half of which, 6,54 feet, is the whole immersing height.

Now as length and breadth are supposed to be the same, therefore multiply 4556 by 6,54.

```
     4556
     6,54
   ------
    18224
   22780
  27336
  -------
  29796,24
```

As the vessel is considered under the same Class as before, use therefore the same divisor, that is, 112.

```
112)29796,24(266,03 lasts,
    224
    ---
     739
     672
     ---
      676
      672
```

with every thing thereunto belonging, as also the ballast.

It now remains to know the weight of the ballast.—For that purpose, take on board so much of the cargo, of iron, boards, and other things, that

that the vessel may not overset when the ballast is taken out.—Suppose now, that what has been taken on board, of the cargo, sinks her down = 13,25 and 11,24. Now when the ballast is taken out, the depth aft is 11,1 feet, and fore 10 feet: subtract 11,1 from 13,25, remains 2,15 feet, which the vessel is lightened aft by taking out the ballast: subtract 10 from 11,24 remains 1,24, which the vessel is lightened fore: add 2,15 and 1,24 together, make 3,39, the half of which is 1,69; which is the height that the vessel is lightened by taking out the ballast. Multiply 4556 by 1,69,

```
   4556
   1,69
 ------
  41004
 27336
 4556
 ------
7699,64:
```

Divide this by 120,

```
12,0)7699,64(64 16/100 lasts;
     72
     --
      49
      48
      --
       19
```

which is the weight of the ballast: and when to this are added the before 266,03

```
  266,03
   64,16
  ------
make 330,19 lasts;
```

which is as before this vessel's burthen.

THE

The foregoing method with respect to measuring and calculating, and to form a proper idea with regard to vessels fulness and sharpness, depends chiefly on practice, and to pay attention to the greater or less continuance of breadth; so that although a vessel may appear full fore and aft, its fulness ought to be considered less, when the midship body does not continue far fore and aft, and in consequence to judge with propriety to what Class she belongs, so as to fix on a suitable divisor.

II.

What the Custom-house Officers ought to pay attention to at the loading and discharging of vessels.

From a vessel's situation when loaded it is known if it has more or less on board than the burthen mentioned in the ship's register: because if the loading marked in the register is below the surface of the water, it has then more on board; and if above the surface, it has less than contained in the register. As there may be a differenee of 3 or 4 lasts in 100 lasts, owing perhaps to the measurer's want of skill, especially if a new beginner, and before he is well versed in his duty;

It

It has therefore been thought proper to remedy this evil by making an allowance in favour of the owner; viz.

On vessels of 500 lasts burthen		16 lasts;
450 ditto		14 ditto;
400 ditto		12 ditto;
350 ditto		10 ditto;
300 ditto		8 ditto;
250 ditto		7 ditto;
200 ditto		6 ditto;
150 ditto		5 ditto;
100 ditto		4 ditto;
75 ditto		3 ditto;
50 ditto		2 ditto;
25 ditto		1 ditto;

or 3 per cent. on the whole burthen, which occasions the loading line expressed in the register to appear a little below the surface of the water, but the vessel is nevertheless considered of the burthen expressed in the register. For example, If the already-mentioned vessel should be so deep loaded that the expressed loading line is half a foot below the surface of the water, it has then certainly greater burthen on board than what answers to 330 lasts; because it will be found on examining the foregoing calculations, that it requires 45 lasts to press it down one foot, half of which is $22\frac{1}{2}$ lasts, requisite to press it down half a foot: as a remedy 9 lasts are allowed; therefore the vessel has certainly $13\frac{1}{2}$ lasts more on board than expressed in the register.

It

fore and aft when loaded as before, therefore 13,38 from 19,25 is 5,87, and 10,79 from 18 is 7,21: add 5,87 and 7,21 gives 13,08, the half of which, 6,54 feet, is the whole immerfing height.

Now as length and breadth are fuppofed to be the fame, therefore multiply 4556 by 6,54.

```
     4556
     6,54
   ------
    18224
   22780
  27336
 --------
 29796,24
```

As the veffel is confidered under the fame Clafs as before, ufe therefore the fame divifor, that is, 112.

```
112)29796,24(266,03 lafts,
    224
    ---
     739
     672
     ---
      676
      672
```

with every thing thereunto belonging, as alfo the ballaft.

It now remains to know the weight of the ballaft.—For that purpofe, take on board fo much of the cargo, of iron, boards, and other things, that

For instance, if a veſſel is become half a foot lighter at any time during the diſcharging of half the cargo, and it is found by the rule page 74 that the weight taken out is eqal to 21 laſts; if Cagliari ſalt has been diſcharged, then have (as 15 barrels make a laſt) 315 barrels been diſcharged. In like manner if the veſſel during the courſe of taking in the ſame half of her cargo has been preſſed down half a foot, then in the ſame manner may be calculated that a burthen of 21 laſts has been taken on board; and if tar, 315 barrels are taken: if the cargo conſiſts of deals, as for example of 7 yards length, 1½ inch thick, and of ſundry breadths, then has about 200 dozen been taken on board, and ſo on.

It ſometimes happens, that a veſſel is loaded deeper than ordinary, ſuppoſe half a foot deeper than the loading line, and conſequently has taken in 22½ laſts more than contained in the regiſter; nevertheleſs, ſhe ought not to be called of 352 laſts burthen, but remain of 330 laſts: it is only requiſite to take notice how much deeper ſhe ſwims than what the regiſter expreſſes; as at another time ſhe may happen not to be loaded up to the determined water-line. In the autumn, and when ſqually weather is expected, it is not cuſtomary to load ſo deep as in the ſpring and ſummer.

that the veſſel may not overſet when the ballaſt is taken out.—Suppoſe now, that what has been taken on board, of the cargo, ſinks her down = 13,25 and 11,24. Now when the ballaſt is taken out, the depth aft is 11,1 feet, and fore 10 feet: ſubtract 11,1 from 13,25, remains 2,15 feet, which the veſſel is lightened aft by taking out the ballaſt: ſubtract 10 from 11,24 remains 1,24, which the veſſel is lightened fore: add 2,15 and 1,24 together, make 3,39, the half of which is 1,69; which is the height that the veſſel is lightened by taking out the ballaſt. Multiply 4556 by 1,69,

```
   4556
   1,69
  -----
  41004
 27336
 4556
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 7699,64:
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Divide this by 120,

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12,0)7699,64(64 16/100 laſts;
     72
     --
     49
     48
     --
     19
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which is the weight of the ballaſt: and when to this are added the before 266,03

```
                 266,03
                  64,16
                 ------
           make  330,19 laſts;
```

which is as before this veſſel's burthen.

THE